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THE
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JANUARY, 1885.

I. THE MISAPPREHENSIONS OF LE VERRIER AND ADAMS
AS EVIDENCE FOR THE
EXISTENCE AND POSITION OF TWO PLANETS BEYOND NEPTUNE.

By the Count O. Reichenbach.

“PENDING Problems in Astronomy” was the Valedictory Address, on September 5th, 1884, of Prof. A. C. Young, past President of the American Association for the Advancement of Science. There is more than one passage in this interesting paper about which I would like to say a word, but I confine myself to one subject.

Mr. Young says “When it is not” “unlikely that some day the searches for asteroids may be rewarded by the discovery of some great world, as yet unknown, slowly moving in the outer desolation beyond the remotest of the present planetary family;” when “some configuration in certain cometary orbits, and some almost evanescent peculiarities in Neptune's motions have been thought to point to the existence of such a world, and there is no evidence nor even a presumption against it;” and when “there is special reason for attempts to determine the rotation periods of the planets, in the fact that there is very possibly some connection between the periods, on the one hand, and, on the other, on the planets' distances from the Sun, their diameters, and masses. (More than thirty years ago Prof. Kirkwood supposed that he had discovered the relation in the analogy which bears his name. The materials for testing and establishing it were then, however, insufficient, and still remain so, leaving too many of the data uncertain and arbitrary). Could such relation be discovered, it could hardly fail to have a most important significance with respect to theories of the origin and development of the solar system." . . .

I do not know of the "analogy," but have seen in the "Observatory" for 1880 that a Mr. Kirkwood writes—"If Laplace's hypothesis cannot be sustained, we may conclude that each planet, at its origin, was separated from a very limited arc of the equatorial protuberance, or, in other words, that instead of the separation of a ring the centrifugal force produces a rupture at the point of least resistance in the equatorial belt." Having in 1843* given reasons for the insufficiency of the original form, pure and simple, of Laplace's hypothesis and theory, I published in 1857† a theory of the common origin, development, and present organisation of the solar system, and therefore feel interested in Mr. Kirkwood's uncertain steps in the direction of a trodden path.

This theory asserted the existence of two more great planets beyond Neptune, for which I got further evidence in 1875.‡ Mr. D. P. Todd did therefore not stand alone with his meritorious inquiry into "some evanescent perturbations in Neptune's motions.§ The peremptory assertions of Prof. George Forbes|| are too cometary to be of account.¶

It is most satisfactory that Prof. Young is not of the opinion of Prof. Newcomb. "It is true that many ingenious people employ themselves from time to time in working out numerical relations between the distances of the planets, their masses, their times of rotation, and so on, and will probably continue to do so, because the number of such relations which can be made to come somewhere near the exact numbers is very great. This, however, does not indicate any law of Nature." Does the accomplished astronomer

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* Weltgebaeude. Charlottenburg, 1843, bei Bauer; and Frankfurt, 1879, bei Ruettgen.

† Gedanken eines Nicht-Gelehrten. Philadelphia, 1857, bei Thomas, pages 113 and following being translated as "Birth and Evolution of the Solar System" in "Journal of Science," London, 1883, February to April.

‡ Two Planets beyond Neptune, and the Own Motion of the Solar System. London, 1875, Wertheimer and Lea.

§ Silliman's American Journal of Science, 1881.

|| Observatory. London, 1880, June.

¶ "Astronomical Notes," Journal of Science. London, 1881, November.

not know that every law has its opposite and unknown? may be therefore deduced from its apparent exceptions? But perhaps he has changed his mind. Besides, his remark does not reach my theory, which gives reasons, and embraces the unknown within the origin and history of the known.

When Prof. Pierce taunted Le Verrier that the planet found by Galle was not the predicted, because all elements, longitude excepted, were wrong, Le Verrier is said to have pleaded that a more distant planet having produced errors from 5″ to 6″ might have led to these mistakes. If this reply should have been made, and is not a wrong version of a passage from Le Verrier's memoirs, we may ask why then he did not enquire more closely into the cause of the mistakes? I shall give quotations from Le Verrier's four memoirs, read before the Paris Academy of Sciences, and published in the "Connaissance des Temps" for 1849, and shall number them for reference.

"*On the Existence of a Trans-Uranian Planet.*"

1. "In the course of the year 1845 Arago represented to me that the importance of this question imposed on every astronomer the duty to concur in clearing it up to the best of his ability."

2. "The theory of Uranus has already given occasion for many hypotheses, but without scientific value, because not founded on rigorous calculations." "Everyone followed the leaning of his imagination, without furnishing reasons for his assertions."

3. Proud of his achievement Le Verrier exclaims on October 5th, 1846:—"So the position had been foreseen to less than a degree." "Thinking of the smallness of the disturbances from which the position of the star has been inferred, this success lets us hope that after thirty or forty years of observation of the new planet it may lead, on its part, to the discovery of the next in distance from the Sun, and so on."

When concurrent signs make it probable that not alone Trans-Neptunian planets, but also a lawful organisation and a limit of our planetary system exist, should an Arago not consider it "the duty of every astronomer to contribute to the utmost of his ability" towards their discovery? Because the errors of Le Verrier are best evidence for the existence and elements of these unknown, I shall point out their extent and bearing.

Admiring the mathematical powers and versatility, and the perseverant industry of Le Verrier, we must yet admit that Pierce was right, and that Le Verrier failed to discover that where he was intent on finding *one* planet, *three* made themselves felt.

4. "In 1820 we possessed forty years of regular meridian observations of Uranus. The planet had besides been observed nineteen times from 1690 to 1771." Bouvard, the author of the first Tables of Uranus, found the discrepancies in its motion so great "that he doubted if they resulted from the inaccuracy of the older observations or from some foreign not perceived action on the planet." Le Verrier sees "the only explanation of the differences between theory and observation" in the existenc "of a planet beyond Uranus."

5. Examination of all observations shows that "the period between 1781 and 1820 offers no trace of great perturbations; on the other hand, it can be connected neither with the preceding nor with the following observations."

"I said already that we satisfy well enough the movement of the planet between 1781 and 1820 without the aid of any extraordinary force. This remark, which seems to prove that the perturbing force has not exercised any perceptible influence during this period, would be sufficiently conforming to the actual hypothesis of a sudden alteration of the motion of the planet. But the period of 1781 to 1820 might connect itself naturally, be it with the former, be it with the later series of observations, and would be incompatible with only one of them. But this is not the case; it may be proved that the intermediate series cannot be made to agree on one side with the old observations, and on the other with the new ones."

Le Verrier returns over and over again to this difficulty without removing it. He calls a' half the great axis of the orbit of the *Predicted*, n' the mean motion, c' the excentricity, w' the perihelion, e' the value of the epoch year 1800, and m' the mass.

6. The first step is a guess at a'. "I said that the planet required cannot be at very little distance from Uranus, and it is not possible to place it at a very great one; for instance, at three times that of Uranus from the Sun." Le Verrier, not of the disposition of Prof. Newcomb, appeals to that metaphysical conjecture the Bode-Titius series. "Is it possible that the inequalities of Uranus are due to the action of a planet situated in the ecliptic at a mean distance double that of Uranus? And if so, where is this

planet at present? what is its mass? what are the elements of its orbit?

7. "If we might determine, at every spot, the variation of the disturbance due to the unknown mass, we might therefrom deduce the direction in which Uranus falls by the incessant action of the troubling body, and we would know the position of the latter. But the problem does not present itself in so simple a form. The numerical expressions of the perturbations might only be immediately concluded from the observations, if we rigorously knew the elements of the ellipsis described round the Sun by Uranus; these elements are again not to be exactly determined unless we know the quantity of each of the figures of a theory. They allow to treat different points of a question without an error with regard to one of these influencing the other. However, it does not appear to me that we might follow this road with perfect safety for the whole work, when we do not know a single relation to be satisfied by the result obtained, and which might serve for their verification. The mutual dependence causes that if the work is not completely correct it is necessarily wrong in every point. Or we comprehend that it is easier to escape this alternative than to the manifold chances of an isolated error."

"Indeed after having treated all perturbations simultaneously, let us return to the calculation of a single one by a direct method; its verification will require that of the whole work. But if, instead of thus controlling a single inequality, we determine successively each one by direct calculation, and then the new results coincide with the first one, all kind of error becomes impossible. It is this double work which I consider necessary to impose on myself in this case."

From this it appears that, notwithstanding this double work, when the disturbances observed and calculated—not knowing "a single relation to be satisfied by the results obtained"—are ascribed to one mass instead of three, the verification of the whole work which is all error will be required, turning the negative or evidently false results into new hypotheses of the existence of one, two, or more masses, as the case may indicate, utilising the one result confirmed by observation, as either accidentally right or as indicating an organic law. This is what I shall endeavour to do, as far as ability and time permit.

8. The following, from the final memoir, is indeed a return from the second to the first method with its dangers. "The methods which, like the preceding, lead at once to determine the perturbations separately one from the other, are most

valuable. But we see the impossibility to separate into distinct parts the research of the elements of Uranus, and of the elements of the disturbing body. It would be vain to hope that in forming empirical equations we might discover, *à priori*, the law of disturbance, but we should run the risk to grossly deceive ourselves, because we should only have obtained an expression qualified to represent the excesses of the disturbances over the errors arising from the inexactitude of the elliptical elements, but not at all the disturbances themselves. There is only one way; it is to form the expressions of the disturbances caused by the new body into functions of its mass, and of the elements of the ellipsis it describes: these disturbances have to be introduced into the co-ordinates of Uranus, calculated by means of the unknown elements of the ellipsis this planet describes round the Sun. Equalising these co-ordinates so obtained to those observed, we take for unknown in the equations of condition which thereby result not only the elements of the ellipsis described by Uranus, but also the elements of the ellipsis described by the disturbing planet of which we want the position."

But when the ellipticity and half the great axis of the orbit and the mass, and everything attributed to the unknown by Le Verrier, differ so much from those of Neptune, how could he be found in the longitude of the predicted ?

The answer shall prove the existence and give the approximate longitude, and more or less the other elements of the two planets A and B.

"The observations extend only over 155 years." The 155 must be embraced in a second solution, "regardless of the amount of labour," after 78 years proved too little.

9. "We conclude that e' falls between 94° 40′ and 189° 55′, or between 263° 8′ and 358° 71′, to make the value of m' positive.

10. "We so might get a negative value of m' corresponding to the positive value of e', whereby the true solution of the problem would be misapprehended. I freely avow that this is what first happened to me, and that the difficulty long detained me."

11. "We see that the value of m' actually changes sign for values of e' included between the points of the circumference obtained."

12. "To definitively know if there exists in this extent a convenient value of e', we had now to attribute different arbitrary quantities to this variable, calculate the corresponding values of m', $m'h'$, and $m'l'$, and examine if one of the

solutions so obtained may represent the motions of Uranus in 1690 and 1747."

13. "When we exclude the negative values of *m*′, and the positive ones too considerable not to be rejected, according to reasons particular to the motions of Saturn, we have to admit that the value of *e*′ suiting the problem, or examining the errors of the theory, leaves it in the position of the planet in 1690 to 1747 for all the values of *e*′ between the limits just indicated, we see that the calculations always differ from observation for at least one of these positions,—a quantity much too great to be attributed to an error of observation, so that the consequence resulting from the discussion seems to me the impossibility to represent the march of Uranus by means of the perturbing action of the new planet."

14. Le Verrier arrives at a contraction of the more or less opposite arcs; "we have to admit that the value of *e*′ suiting the problem must be comprised between 108° and 162°, or between 297° and 333°," but "calculation always differs from observation for one at least of these two positions," and we again arrive at the "impossibility to represent the march of Uranus by the disturbing influence of the new planet."

15. "Let us remark" "that the conclusions at which we would arrive may not be the expression of the truth. The motives given, to legitimate this way of judging, will receive new force by the following remark. Imagine that we went through the preceding discussion omitting the two following inequalities in longitude." (— —.) "These two disturbances are so feeble that it seems they might be omitted without affecting the final result. But nothing of this."

16. "The preceding details seemed indispensable to make the reader understand all the difficulties in questions like that before us. Without them we could not have seized the importance of the modification made in the preceding march to definitively solve the problem." "The result to be arrived at will confirm in a remarkable manner the previsions of No. 8. We shall prove, contrary to the conclusions which seemed to follow from the preceding discussion, that it is possible to represent the march of Uranus, in accounting for the disturbing influence of the new planet; that the length of the epoch *e*′ of this new star must be 240°; and that this hypothesis, the expression of the truth, would be repulsed by the negative value found for the mass."

17. "It is sufficient to discuss in the same manner the error of the theory in 1758, and, in attributing increasing

values to e', to become aware that they are all inadmissible from 99° inclusive. *From beyond that point towards* 108° it would not be impossible to find admissible values for m', P', Q', neutralising the error of theory in 1758 or 1747, when we consider *one* of the epochs *by itself*."

"We perceive, however, that the errors of the theory incessantly go on diminishing as e' increases from 189° forward, and that the errors become simultaneously very small when e' attains 245° to 252°." Beyond new change on to 360°.

18. "It appears, therefore, that we can effectually account for the motions of Uranus by means of a disturbing planet."

19. "We may infer that the mean longitude of that planet was 243° to 252° on 1st January, 1800."

Le Verrier finally assigns to the Predicted a h.c. longitude on the 1st of January, 1847, 326° 32′; a mean solar distance, 36·156; an excentricity of orbit, 0·1076; a longitude of perihelion, 284° 5′ 48″; an inclination of orbit to that of Uranus of at least 4·38; a precession from 1st of January, 1800, in 47 years 0′39·20; a period 217·387 years, and a mass 1÷9322 of the Sun.

20 "The new planet whose existence and place was fixed in heaven by the investigation just read" was found by Galle at Berlin, two days after he had received the data from Le Verrier.

The h.c. longitude got by observation was for January 1st, 1847	327° 24′
That assigned by Le Verrier	326° 32′
Difference...	0° 52′

When I venture, from a metaphysical standpoint, to criticise this scientific triumph, it is not to disparage the merits of the accomplished analyst, but to prove by his mistakes that the organisation of the solar system and the two planets exist.

From the publications quoted it may be seen when and why I made the planetary mass 1÷680 of the solar, divided it in 680 parts, and assigned to Uranus, Neptune A and B 104·2 parts, and to the two latter the other elements as given in the Table; and the h.c. longitude, January 1st, 1875, to A 196° with error in more, to B 308° with error in less.

Biassed from my first view by the then adopted masses, I distributed the 1÷4468 of the solar mass:—Uranus, 1÷24608; Neptune, 1÷14446; A, 1÷12962; B, 1÷22927. I now accept Prof. Newcomb's 1÷22608 for Uranus, 1÷19360 for Neptune, together 1÷10428, and divide the remaining 1÷7726 according to the "development theory"—

$$A : B = 1 : 1 \div (1{\cdot}22^2 \times 1{\cdot}025^2) = 1 \div 13200 : 1 \div 18619.$$

Uranus + Neptune to A + B, as Mercury + Venus to Earth + Mars; moons, asteroids, &c., inclusive.

That the existence of the two planets and their elements, longitude excepted, were determined by the metaphysical development theory, before I knew at all of Le Verrier's misapprehensions, is certainly evidence for the theory.

Le Verrier first found a positive *m′*, and therewith *e′*, to fall between 94° 40′ and 189° 55′, or between 263° 8′ and 358° 41; then in narrower limits, between 108° and 162°, or 297° and 333°; there were two chances to select from. But "for certain reasons" both are "inadmissible;" we get to an "impossibility" against the nature "of the problem." "There is only one way" to its "final solution;" it is to form the expressions of the disturbances caused by the new body into functions of its mass and of the elements it describes. A negative *m′* is metamorphosed into a positive "between 245° and 250°." "From beyond 99° inclusive towards 108° it would, however, not be impossible to find admissible values," "when we consider *one* of the epochs *by itself*."

Neptune is, of the outside planets, the one most perturbing Uranus, and the greatest perturbations must fall in the time of conjunction. Such proximity of the planets was therefore indicated; it fell within the time of observations during the 155 years. Le Verrier therefore endeavoured to bring his *one* planet, to predict, at the right time in this longitude. But as Uranus was also disturbed by A and B he had to invent, for his *one* planet, elements suiting his wants.

He concluded a compromise: he cast Neptune and A into one. He invented a solar distance not that of Neptune, and a mass not that of Neptune plus A, for a fictitious being, and more or less reconciled the discrepancies between theory and observation in the distribution of the individual disturbances in magnitude and time by a great excentricity, 0·1076, that of Neptune being 0·0089; and a perihelion in the conjunction longitude of Uranus and Neptune 284° 45′, that of Neptune being in 46° 6′ 39″. He placed his unknown almost in the middle between Neptune and A, at 6·120 from the former at 5·844 from the latter. According to the excentricity intercalated, between Neptune and A, for the Predicted, it moved 3·89 farther, and nearer than its mean distance from Uranus. Le Verrier placed the mean orbit of the Predicted at 16·97 from that of Uranus: Neptune is at 10·85. This reduces the perturbing power in its mean, comparing Neptune to the Predicted,—

$$16{\cdot}97^2 \div 10{\cdot}85^2 = 2{\cdot}46 \text{ times.}$$

This loss of power by distance had to be balanced by mass.

21. "The search for the value of *m′* is a very delicate point," says Le Verrier. The mass of Neptune is 1÷19360; Le Verrier made that of the Predicted 1÷9322, about 1÷26 more than double, but not that of Neptune plus A. Had he done this he would have balanced loss by distance by mass, for $1 \div 13200 + 1 \div 19360 = 1 \div 7848$ exceeds the mass of Neptune 2·46 times. As it was, he attributed to his planet only a mass 2·077 times that of Neptune, and left against the loss of power by distance an unsatisfied balance of 0·38.

When we apply the distance and mass attributed to the Predicted, we find that it would exercise at its perihelion an influence 1·423 times greater, and at aphelion 1·789 times less, than that exercised by Neptune at mean distance, which is in sum a variation of 1÷3·212 in the disturbing power of the Predicted.

When we apply the elements of Neptune and A in comparison, the former exceeds A in perturbing power by distance $2{\cdot}103^2 = 4{\cdot}42$ times, and acts less by mass 1·46 times. Neptune therefore exceeds A in this power 3·027 times, which gives a difference of only 0·185 with the variation 3·212 of power by excentricity of the fictitious planet.

For such slight differences various causes may exist; but the dominant cause is B, whose perturbing power is 1÷26 of that of Neptune and 1÷8·7 of that of A. It moved in 155 years only through about 88°. When B came in conjunction with Uranus and Neptune it became a part substitute for far-off A: the excess of 0·077 over the 2, in the point of mass, may be therefore considered as equivalent of the 1÷26, and the deficiency 0·38 of mass balancing distance as more or less representing the absence of A in the time of conjunction of the other three planets.

The disturbance of Uranus by B may be indeed traced as concrete and dissolved in the most "rigorous calculations," —a remark illustrated by the following quotations.

22. "All these" minor "differences between theory and observation may be very well put on account of the latter," or may be accounted for by B.

23. "There will be no exception" to the perfect agreement of theory and observation, "but for equation (25) founded on the observations from 1824 to 1827, the error, which remains almost always the same in the equation, whatsoever be the hypothesis, is from 5″ to 6″."

Le Verrier abandoned for the *one* planet the sound basis of his most "rigorous calculations," where in 1800 the two arcs with positive m' included the first one A, the second B, and had Neptune in the midst of their neighbouring terminals (189° 55′+263° 8′)÷2=226° 31′. He struck out for the periods and longitudes of greatest disturbances as those of probable conjunction of Uranus and the one planet, connected these periods by an ingenious combination, and obtained a success.

The Predicted was not Neptune; but Le Verrier has not only indicated the longitude of one planet out of three, but also that of A and B.

		Uranus.	Neptune.	Predicted.	A.	B.
Solar distance..	—	19·18	30·03	36·156	42	76
Perihelion	—	167° 32′	46° 6′ 39″	284·45°	9° ?	62° ?
Excentricity	—	0·0046	0·0089	0·1076	0·0041 ?	0·1156 ?
Revolution years	—	84·07	166·6	217	272	662
Conjunction years	—	—	171·4	136·6	121·34	97·3

Longitude on January 1st:—

	Year.					
	1778	79·3°	—	—	79·736	—
e'	1800	174°	224·5°	—	108·776°	279·573
Motion taken	1825	280·84°	279·308°	— ·	141·766°	279·573
Circular for A and B ..	1847	—	327° 24′	326° 32′	—	—
	1885	—	—	—	221° or less.	314° or more or less.
	1899	239°	—	—	239·256°	—

The greatest differences observed during the 155 years, indicating positive m', fell in the period between 1824 to 1827, and in 1690. After two failures to satisfy all observations by the *one* planet, Le Verrier put the perihelion of an orbit into 284° 45′, about the longitude of Uranus, on January 1st, 1826. The time from 1690 to 1826 is 136 years, the mean period of conjunction of Uranus and the Predicted or fictitious; but, as the latter was not Neptune, it was already slightly behind the real planet in 1847, and had been in advance in 1800.

I now refer to quotations 9 and 17. "From beyond that point towards 108·776°," &c. I select 108·776 (s. quot. 14) to place it against the year 1800 for A. There was a conjunction of A with Uranus in 1778, between the observations of 1771 and 1780. I placed slow-moving B in 1825 at 279·573°, before I saw Le Verrier's memoirs; circular motion then gives 265·348° in 1800. We had in the "second solution" 108° as beginning of an arc with positive *m′*; we have in the first solution 263° 8′ as beginning of the second arc. Neptune, as before said, was right in the middle of the negative *m′* between an ending and commencing arc with positive *m′*, with A and B between 189° 55′ and 263° 8′ in 226° 32′.

Going back with conjunctions with Uranus before 1670, we meet them with B about 1630; with Neptune about 1654, with A about 1657, in such quick succession that they throw their combining shadow before them to 1690.

Of Prof. Adams's investigation I know only what Sir G. B. Airey wrote in the "Monthly Notices of the Royal Astronomical Society" (1846). His first hypothesis had distance 38·4 based on the Bode-Titius series, the second "about 1-30th less." He adopted—if from the commencement or not does not appear—the method Le Verrier followed in his "final solution." His figures were—first and second hypothesis distance, 38·4, 37·12; perihelion, 313° 57′, 299° 11′; excentricity, 0·16103, 0·120615; mass, 1÷6040, 1÷6666; longitude (Oct. 1st, 1846), 325° 8′, 323° 2′.

No. 1 placed the aphelion at distance 42·1; No. 2 at 41·59. The mass for No. 2 is 2·904 times that of Neptune; the change of power on Uranus from perihelion to aphelion is 2·77 to 1. The loss of power from Neptune distance to aphelion distance of the fictitious is 4·26 to 1. We perceive here the difference in the treatment of mass by Le Verrier and Adams. The masses A to Neptune we had 1·46 to 1 and 4·26÷1·46=2·91.

It is easily seen that the first hypothesis—aphelion 42·1, the distance of A, giving the mass 3·205 times that of Neptune—reproduces the relation of power on Uranus from Neptune and from A by the series of fictions invented to find *one* planet instead of two, and that the second hypothesis originated from the interfering B, the third planet, to remove the error of from 5″ to 6″ mentioned by Le Verrier.

We can only wish that the distinguished mathematician would once more apply his talents and influence to secure the early theoretical and visual discovery of the two still unknown great planets of the solar system.

II. RECENT DEVELOPMENTS OF CHEMICAL SCIENCE.

SEVEN years ago we ventured to insert in the "Journal of Science" a paper bearing the somewhat ambitious title "The Chemistry of the Future." In that paper emphasis was laid on the unsatisfactory state of our knowledge concerning the simple bodies or so-called "elements," and attention was called to certain lines of research which promised to throw further light upon this difficult though interesting question. Of these investigations two seemed to offer direct evidence that the elements are not primordially distinct bodies, but compounds of a smaller number of elements of a higher order, or perhaps have even been formed by the "expansion"* of one aboriginal principle. We refer here, in the first place, to the researches of Prof. Victor Meyer on the halogens — chlorine, bromine, and iodine. The phenomena observed by this chemist seemed to admit of the conclusion that, given a sufficiently high temperature, bromine and iodine might be resolved into chlorine. But this prospect has since faded away. It is generally admitted that Prof. V. Meyer's experiments afford no conclusive proof that either bromine or iodine has undergone incipient decomposition. It is needless to add that in such a matter, where the temptation to indulge in hypothesis is naturally so strong, nothing short of absolute demonstration can be accepted as satisfactory.

The second line of investigation, which it was hoped might supply evidence of the decomposition of some of our ordinary elements, has fared little better. The spectroscopic researches on the constitution of the sun and certain of the fixed stars—with which the names of Mr. Lockyer and Dr.

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* *See* Journal of Science for January, 1877, p. 26.

Huggins are especially connected—seemed to show the behaviour of certain elementary bodies at temperatures prodigiously higher than any which we can produce in our laboratories. But here, again, though the investigation has not been brought to a definite conclusion, the verdict of the most judicious chemists and physicists is, so far, "Not proven." Prof. Sir H. E. Roscoe, in his opening address at the meeting of the Chemical Section of the British Association at Montreal, does not refer to the decomposition of any of the elements as a subject within the present scope of practical research.

In proof of the difficulty of deciding such a question by spectroscopic research alone, Prof. Liveing stated at the Montreal meeting that cadmium, mercury, and zinc, as well as aluminium and tin, give no spectra at all at sufficiently high temperatures. Iron, on the other hand, shows so many lines that it either must have a very complex constitution or else it is really formed of a number of elements having nearly identical atomic weights, and which, so far, defy separation.

We are therefore driven back to what may be called the indirect evidence for the compound nature of the elements. Under this head we gave, in 1877, an exposition of the "periodic theory" of Mendelejeff and Lothar Meyer, or rather, we should say, of Newlands. The natural relations of the elements thus brought to light are scarcely conceivable if these bodies are initially distinct, independent entities, but are quite compatible with the supposition that they have been evolved from some common principle.

Now the evidence in favour of the "periodic law" has been of late materially strengthened. It is more and more found to lend itself to the rational interpretation of new classes of phenomena. One of its most interesting applications has recently been made by Prof. T. Carnelly to the state in which the elements occur in Nature. This chemist refers, in the outset of his memoir ("Berichte der Deutschen Chemischen Gesellschaft," vol. xvii., p. 2287), to three facts laid down by Mendelejeff in his first paper on the Periodic Law ("Annalen der Chemie und Pharmacie, "Supplement 8). These three facts are—

a. That although all elements belonging to the same group evince close natural relations, yet the elements of the even series are more nearly connected with each other than with those of the odd series, whilst in like manner the elements of the odd series are more nearly related to each other than to those of the even series.

b. In the elements of the second series the foregoing rule is often reversed from carbon to fluorine, and in the third series from sodium to silicon inclusively. This appears very distinctly on examining Lothar Meyer's "curve of the elements." See his "Moderne Chemische Theorien," or Pattison Muir's "Principles of Chemistry," p. 227). This curve, on reaching carbon, instead of falling, rises until it meets sodium, and then falls from sodium to silicon, instead of rising. This inverted character of the curve accurately illustrates certain properties of the elements which lie within the limits above mentioned.

c. The elements belonging to Mendelejeff's eighth group are peculiar in many respects. They form, unquestionably, the connecting-links between the even series on the one hand, and the odd series on the other. This fact is illustrated by Meyer's curve, which shows that they form, step by step, a transit from the even to the odd series, or rather from the ascending to the descending parts of the curve. The elements of this group are found at the lowest points of the curve.

After having thus laid down the preliminaries upon which he takes his stand, Prof. Carnelley proposes the following law:—

1. Elements which belong to uneven series are, as a rule, easily obtained in the free or uncombined state, whilst those belonging to the even series cannot without difficulty be liberated from their combinations.

The only exceptions to this rule—somewhat numerous, it must be confessed—are carbon, nitrogen, oxygen, sodium, aluminium, and silicon, the explanation of which is found under Mendelejeff's rule *b*, and also the elements of group VIII. (See *c*.)

2. As regards the occurrence of the elements in Nature, in a free state, a point naturally connected with their readiness in being expelled from combination we have then the following law:—

Elements belonging to the even series (with the exception of carbon, nitrogen, oxygen, and the eighth group) never occur in Nature in a free condition, whilst the elements pertaining to the odd series may generally speaking, and even frequently, be found in the free condition. Instances of simple bodies thus frequently met with uncombined are—Copper, silver, gold, mercury, arsenic, antimony, bismuth, sulphur, selenium, and tellurium ; lead and tin occasionally occur naturally in the metallic state. Gallium, indium, thallium, and cadmium are of such rare occurrence that we can scarcely venture to state whether they occur in the free condition or not. Among the bodies which belong to the uneven series, and still are not met with in the free state, only chlorine, bromine, iodine, fluorine, zinc, and phosphorus are noteworthy exceptions, whilst sodium, magnesium, aluminium, and silicon are explained by Mendelejeff's principle *b*. As regards the exceptions among the even series, carbon, nitrogen, and oxygen come under *b*, and the group VIII. under *c*.

3. As concerns the occurrence of the elements in Nature in a combined condition, Prof. Carnelley, leaving the elements chlorine, bromine, iodine, and fluorine, and the group VIII., for future consideration, proposes that—

The elements belonging to the odd series generally occur in Nature as sulphides or double sulphides (or selenides, tellurides, and arsenides),—*i.e.*, in combination with a negative element belonging to an odd series,—and only in very rare cases as oxides. Elements belonging to the even series are generally found as oxides or double oxides (with the formation of silicates, carbonates, sulphates, aluminates, &c.),—that is to say, with a negative element belonging to an even series,—and in two instances only as sulphides.

Thus the following elements belonging to the even series occur as oxides or double oxides :—

Commonly : Lithium (in lepidolite, &c.), potassium (in saltpetre and felspar), rubidium, cæsium, beryllium, calcium, strontium, barium, boron, scandium, yttrium, lanthanum, ytterbium, carbon, titanium, zirconium, cerium, thorium, vanadium, niobium, didymium, tantalum, oxygen, chromium, tungsten, manganese.

Frequently : Nitrogen (in saltpetre), molybdenum.

Rarely or never : None.

As sulphides :—

Commonly : Molybdenum.

Very rarely : Manganese, also oxygen as sulphurous acid in volcanic gases.

Elements belonging to uneven series occur as sulphides (selenides or tellurides) :—

Commonly : Copper, silver, zinc, cadmium, mercury, gallium, indium, thallium, lead, antimony, sulphur, selenium, and tellurium.

Frequently: Arsenic, bismuth, tin.

Never: Gold (occurs only in the free state), sodium, magnesium, aluminium, silicon, phosphorus. (See *b*.)

As oxides:—

Commonly: Sodium, magnesium, aluminium, silicon, phosphorus (see *b*), and tin.

Frequently: Zinc and copper.

Rarely: Lead, antimony, bismuth, and arsenic.

Group VIII.—The elements of this group, with the exception of iron, cobalt, and nickel, never occur in combination. Hence we need consider merely these three bodies.

Iron occurs mostly as oxide, but still also frequently as sulphide. Cobalt is met with mostly as sulphide, but often also as oxide. Nickel occurs chiefly as sulphide and arsenide, and but very rarely as oxide.

Iron, the first member of this group, approaches closely to the elements of the even series, whilst nickel, the last member, approximates much to those of the odd series. This is a proof that group VIII. affords a gradual transition from the even to the odd series.

The halogens, chlorine, bromine, iodine, and fluorine—the most electro-negative elements—occur in Nature in combination with the most electro-positive metals, as chlorides, bromides, iodides, and fluorides, and (if we disregard a few metallic oxychlorides and sulpho-chlorides) never in combination with oxygen or sulphur.

The above-mentioned facts may thus be summarised with reference to Lothar Meyer's elemental curve:—

Elements whose position is on descending parts of the curve are reduced with difficulty, and never occur in Nature in the free state or in combination as sulphides, but always in union with oxygen as oxides or double oxides (silicates, sulphates, carbonates, &c.); whilst the elements which have their position on ascending points of the curve are easily reduced, and occur almost invariably to a greater or less extent in a free condition, or in combination with sulphur, and very seldom with oxygen.

Another investigation by Prof. Carnelley likewise deserves notice here, as it connects itself with the periodic law, and thus, indirectly at least, strengthens the evidence in favour of the compound nature of our supposed elements.

The more immediate object of the author's researches is the colour of chemical compounds, viewed as a function of the atomic weights of their component elements. In a memoir on this subject communicated to the "Berichte der Deutsch. Chem. Gesell." (vol. xvii., p. 2151), he remarks that the colour of chemical compounds depends on at least three conditions, namely,—1, the temperature; 2, the quantity of the electro-negative element; and 3, on the atomic weights.

The two former of these conditions have been especially studied by Ackroyd ("Chemical News," xxxiv., p. 76). Long previously a paper on the second of these conditions was read before the Chemical Section of the Manchester Philosophical Society. This took place between the autumn of 1849 and that of 1853; but as we cannot give the precise date, and have no means of referring to the original document, we suppress the name of the author. His conclusions agreed very closely with those reached by Mr. Ackroyd under the second head.

The conclusions of the latter chemist are—

I. All the chrome compounds change their colour in a fixed succession, in the order of the spectral colours, and in such a manner that the colour, as the temperature rises, approximates more and more to the red end of the spectrum, and passes ultimately into brown and black if the heat is sufficient. The transition of colour is generally direct from white to a pale yellow, violet, indigo,—blue and green being overleapt.

II. In binary compounds an increase of the proportion of the electro-negative element involves a modification of colour towards the red end of the spectrum, and finally into brown and black. Thus PbO is yellow, Pb_3O_4 red, and PbO_2 brown.

III. Prof. Carnelley's law as to the influence of the atomic weight is as follows:—In certain series of compounds, $Ax\,Ry$, $Bx\,Ry$, $Cx\,Ry$, &c., in which R is an element or group of elements, whilst A, B, C., &c., represent elements belonging to the same sub-group of the periodic classification, the colour passes either entirely or partially through the following scale:—White or colourless, violet, indigo, blue, green, yellow, orange, red, brown, black,—or, in other words, the higher the atomic weight of the elements A, B, C, &c., the more the colour of the compound approaches the red end of the spectrum, passing in certain cases into brown and black.

It must be observed that the above law refers only to cases in which A, B, C, &c., are elements belonging to the same sub-group, but not to cases where they belong to different sub-groups. Thus oxides cannot be directly compared with the corresponding sulphides, selenides, and tellurides. Nor can fluorides be compared with the corresponding chlorides, bromides, and iodides, for fluorine and oxygen belong to even series, whilst chlorine, bromine, iodine, and sulphur, selenium, and tellurium pertain to odd ones.

It must likewise be remembered that the above rule applies strictly only to solid compounds, and that in the solid state the colour can within certain limits change with the condition of aggregation.

In addition to 426 cases in which the law has been verified, Prof. Carnelley meets with fourteen exceptions. Four of these, $DiCl_3$, V_2O_5, CrO_3, and CaO, do not seem to admit of any satisfactory explanation. He considers that the colour of a compound will ultimately prove to be a periodic function of its atomic weight. This may best be seen on considering the normal iodides. If we construct a curve in which the ordinates represent the atomic weights of the positive elements, and the abscissæ form a scale rising from black, through brown, red, orange, yellow, green, &c., to white, the curve thus obtained resembles in figure Lothar Meyer's well-known elemental curve.

Could Prout's hypothesis—*i.e.*, that the atomic weights of all the elements are multiples by whole numbers of that of hydrogen ($=1$)—be demonstrated, it would have contributed no little to prove that these bodies are genetically connected. But the most careful re-determinations of the atomic weights lead us in the very opposite direction. Instead of the exceptions to the supposed law disappearing, on more exact scrutiny they persist, or are even increased.

One indirect consideration in favour of a common evolutionary origin of the elements has, perhaps, scarcely received the attention which it deserves,—*i. e.*, the occurrence in intimate admixture of bodies having very similar properties, and sometimes even closely approximating atomic weights. Such groups are, *e.g.*, cobalt and nickel, the three halogens, and especially the rare earths found together in samarskite, &c. It is difficult to frame a hypothesis which will account for the co-existence of these various groups of bodies, save the one that they have been evolved out of some common material.

But this, and all other indirect evidence pointing in the same direction, is very far from meeting the demands of Science, We are no nearer than we were half a century ago to the decomposition of any element, or to the metamorphosis of one into another. In one sense even we are further off. Considering the greatly improved means of research which chemists now have at their disposal, and the number of well qualified *savants* who have attacked this problem from different sides, we feel that the probability of a solution is lessened. We can only hope that some untried path, of which the world has no conception, may some day lead to the desired end.

III. NEW RESEARCHES ON THE FECUNDATION OF ANIMALS.

FECUNDATION AND SUBSTITUTION.

THE remarkable advances made recently in the study of the fecundation of animals are known to all biologists. A recent monograph by Prof. E. van Beneden, summarised in the "Naturforscher," developes a new apprehension of the essence of this process, and compels us to recur to this important question.

The modern views on the process of fecundation, as they are now universally accepted, date back to the researches of Bütschli. This *savant* was the first to show that in the yolk of the fecundated ovum of *Rhabdites dolichura* there appear two nuclei which soon move towards the centre of the yolk, and coalesce to form the nucleus of the first embryonic cell. Two years afterwards, in 1874, this discovery was confirmed by the researches of Auerbach. A little later Bütschli discovered, further, that in place of the germinal vesicle there appears a fibrillary spindle (the spindle of direction) like that which is formed in the cell-nucleus in the moment of segmentation. This spindle takes part in the formation of the polar vesicles, which, as it is known, are expelled from the ovum.

In 1875 E. van Beneden found that the observations which Bütschli had made on Nematoids hold good also as regards mammals. He observed, further, that the two nuclear elements possess different properties. The one makes its appearance near the surface of the ovum at the moment when the other already occupies the centre of the yolk. Both germs, as they approximate to each other, increase in size. Even after the union of both elements in the centre of the yolk, the nucleus which has been formed at the circumference possesses attributes which serve to identify it with the essential constituent of the spermatozoa. Hence the pronuclei may be distinguished as a male pronucleus derived from the periphery of the ovum, and a female formed in the yolk.

Soon afterwards there appeared the important investigations of O. Hertwig, in which it is proved that the sperm-nucleus is evolved from the spermatozoon, and the germ-nucleus from the yolk, which then unite in the well-known manner. Fol subsequently observed how the spermatozoon penetrates into the yolk. This fact—the penetration of the spermatozoon and its share in the formation of the male pronucleus—has been verified by all succeeding investigators. Observers differed among themselves only in the manner in which this penetration occurs, and on the part which it plays in the formation of the male pronucleus. Broadly speaking, the views of Hertwig and Fol—that the spermatozoon finds entrance into the yolk, that a portion of it becomes the sperm-nucleus which combines with the ovum-nucleus to form the segmentation-nucleus—were universally acknowledged. On the minor details, such as the formation of the fibrillar spindle and the stellar bodies or polar vesicles, their signification and destiny, the manner of the penetration of the spermatozoon and its part in the formation of the sperm-nucleus, there still prevailed differences of opinion.

This posture of affairs induced Beneden to resume the investigation of the process of fecundation. For his observations he selected *Ascaris megalocephala*, the most suitable subject at once on account of its size and the simplicity of its organisation.

In his monograph detailing the results of his investigations, after a preliminary account of the present state of the question and of the methods employed, he discusses the changes which the ovum undergoes during the first period of ripeness. He then describes the entrance of the spermatozoon into the ovum, or the conjunction of the sexual products; he considers the second period of the maturity of the ovum, and the changes which the spermatozoon experiences in this period. He takes up next the formation of the male and the female pronucleus, the fecundation and the segmentation of the first embryonal cell. Finally he gives the conclusions deduced from the results of his observations, which we shall here summarise from the "Archives de Biologie" and the "Naturforscher":—

The ovarian ovum yields to the ovum-gonocyte a protoplasmic body (which is reduced by the absence of the matter forming the strata deposited around the yolk), and a nucleus which is reduced by the repulsion of the partly chromatic and partly achromatic elements which enter into the composition of the polar vesicles. The germinal vesicle undergoes a first reduction at the time of its apparent disappearance. A part of its substance is then mixed with the protoplasm of the egg, and this reduced nucleus is the female pronucleus.

On a former occasion I used the term gonocyt to express a cell-body which possesses two nuclear elements with different sexual properties. I have applied this name to the organism of the Infusoria which possess an endoplasm and an endoplastula, and also to the body of the ovum which possesses both pronuclei. But it follows clearly, from the study of fecundation in *Ascaris megalocephala*, that an ovum possessing its two pronuclei is exactly the equivalent of an ordinary cell. I have proved that in the nuclei of each of the two first blastomeres (segmentation-cells) we find the equivalent of a male semi-pronucleus and a female semi-pronucleus. It is also probable that the same will hold good in the cells thence derived. A cell with a single nucleus differs thus in nothing from a cell with two distinct pronuclei.

An examination of the division of a cell with two pronuclei shows that it takes place exactly like that of a single cell. A cell with two pronuclei cannot, therefore, require a distinctive name. It is useless therefore to employ the word gonocyt in order to denote this hermaphroditic element, or any other cell. But instead of banishing this word from the vocabulary of the cell-doctrine (we hesitate at saying cellology) it seems to me that it might be usefully retained in a modified acceptation. I propose to use it with the respective addition of the adjectives "female" or "male," in order to designate the ovum reduced in consequence of its ripeness, and the spermacyt after the repulsion of its cytophoral portion after it has become a spermatozoid.

But if from a morphological point of view, and considered in their structure, the pronuclei differ in nothing from ordinary nuclei, it is clear that, physiologically speaking, they are in no wise equivalent to nuclei. Each pronucleus is rather equivalent to a half-nucleus which presents, from its origin, a uni-sexual character. This is the justification for the term "pronucleus," which I originated, and which is now generally adopted. But if the female pronucleus is not the equivalent of an ordinary nucleus it is clear that the yolk-globe, with its pronucleus, is not a cell. If a particular name for the nuclear element is justifiable, it is, in like manner, for the cell-body. I propose, therefore, the name "female gonocyt" for the yolk-globe with its pronucleus.

As for the spermatozooid it is distinguished by many peculiarities from every true cell-element. We never observe the division of a spermatozoon. Its nuclear element becomes a pronucleus, and is therefore not equivalent to a nucleus. Hence the body of the spermatozooid is not a cell, and it may be suitably known as a male gonocyt. This element is distinguished in its origin from every other cell by the circumstance that the spermacyt, from which it is derived, becomes a spermatozoid only by divesting itself of a part of its substance. The part thus thrown off by the spermatocyt is the cytophor, or more correctly the cytophoral portion.

I do not need to revert here to the view which I have advanced above concerning the signification of the phenomenon of fecundation. I am of opinion that that fecundation consists essentially in the completion cf the female gonocyt and its transformation to a cell,—that is, in the replacement of the eliminated elements of new matter derived from the spermatozoon. The eliminated nuclear elements (polar vesicles) are replaced by the male pronucleus; and as the polar vesicles together with the female pronucleus formed a cell-nucleus, the germinal vesicle in like manner, the male pronucleus, and the female pronucleus form together a single cell-nucleus. It is indifferent whether these two pronuclei coalesce visibly to a single element, or if they remain distinct. There exist grounds for the assumption that even in the ordinary nuclei the male chromatine remains separate from the female chromatine.

The protoplasm of the male gonocyt is mingled likewise with the body of the female gonocyt. But is this a substitution? Is it in the same sense essential as the substitution of a part of the nucleus? The question may be discussed, but for the present it is hard to decide.

After Hensen, in his treatise on Generation, has expounded the views of Hertwig on the nature of fecundation, he adds :—" These are the views which are opening out ; their full theoretical elaboration has not yet taken place, partly because the behaviour of the nuclear threads or the original nuclear substance has not yet been examined, partly because the fact that the head of the spermatozoid becomes a nucleus is still contested." On the other hand, Flemming, after showing that the chromatine of the sperm-nucleus mixes with the female pronocleus, and contributes to increase the quantity of the chromatine of this latter element, admits that he does not know what becomes of the light halo surrounding the chromatine of the sperm-nucleus :—" What becomes of the light halo which still surrounds the central corpuscles of the sperm-nucleus, when the the two nuclei meet together, I have not been able to ascertain."

I believe I have taken an additional step in the comprehension of the phenomena of fecundation by showing :—

1. That not merely the chromatic nucleus of the spermatozoon, but also the surrounding achromatic layer (perinuclear stratum, participates in the formation of the male pronucleus.
2. That the germinal vesicle furnishes the female pronucleus not only with chromatic elements, but also with an achromatic body.
3. That the two pronuclei, without becoming intermixed, may attain by progressive maturation the constitution of ordinary nuclei.
4. That in *Ascaris megalocephala* a single nucleus is not formed out of the two pronuclei, and that a segmentation-nucleus—in the sense which O. Hertwig gives to the word—does not exist. The essential point of fecundation does not lie in the union of the two nuclear elements, but in the formation of these elements in the female gonocyt. One of these nuclei is derived from the ovum, and the other from the spermatozoon. The nuclear elements expelled in the form of the polar elements are replaced by the male pronucleus, and as soon as two half nuclei (a male and a female) have been formed the process of fecundation is completed.

In consequence of a series of transformations which the nuclear structure of each pronucleus undergoes,—transformations identical with those which take place in every nucleus undergoing division,—each pronucleus produces two chromatic loops. These four chromatic loops take part in the formation of the chromatic star, but they remain distinct. Each of them becomes divided longitudinally in two secondary twin loops.

The nuclei of both the first blastomeres receive each a half of each primary loop, or four secondary loops, of which two are male and two female.

There occurs therefore no interfusion between the male and the female chromatine in any stage. If such a process takes place it can only be in the nuclei of the two primary blastomeres. There is reason for believing that even in these nuclei the male chromatine remains distinct from the female. It is certain that the male chromatine never unites with the female to form the primary embryonal nucleus. We cannot, therefore, maintain with Hertwig that fecundation consists in the union of two nuclei, a male and a female. No such union takes place in *Ascaris*. If it occurs in other living beings it is probably only in appearance, and it is certainly not the essential part of the phenomenon. *Fecundation is, in its essence, substitution,—i.e.*, the replacement of a part of the germinal vesicle by nuclear elements derived from the spermatozoon, and perhaps also of a part of the protoplasm of the ovum (perivitelline substance) by the spermatic protoplasm.

The elements of male and female origin do not coalesce to one segmentation-nucleus, and remain probably distinct in all the cells descended from them.

The study of the maturation of the ovum, of fecundation, and of cell-division have confirmed me in the view that the cell-nuclei are hermaphroditic, and this the more as the male chromatine does not coalesce with the female chromatine. If the male and the female pronucleus deserve their respective names, which pre-suppose their sexuality, the cell-nuclei are evidently hermaphroditic. *The tissue-cells have this character in common with the Protozoa and the Protophytes.*

I consider fecundation not as generation. This characteristic phenomenon of cell-life consists in an exchange, and not in the genesis of a new cell-individual. The substitution of certain elements of a cell by similar parts, supplied by another cell, renders possible the unlimited preservation of life, and renders further increase possible. We can conceive of generation (reproduction) only as an increase of individuals. It is probable that in reality there exists only a single mode of increase-fission. In fecundation there is no increase in the number of individuals. This is very clear when fecundation appears in the form of conjugation, or even in the type in which it occurs in the Vorticellæ. A *Vorticella*, A, resolves itself into a macrospore, M (female gonocyt), and a microspore, *m* (male gonocyt). Another *Vorticella*, B, is similarly split up into M and *m*: M then coalesces with *m*, and M with *m*. There are formed thus two renovated individuals, A and B, but there is no increase in the number of individuals. After fecundation, as well as before, there are only two Vorticellæ. Fecundation as it is performed in the Metazoa follows the same plan. An ovum, A, is divided into a female gonocyt, G, and in polar vesicles, *g*; a spermacyt is split up into a cytophoral part, C, and a spermatozoid, *s*. We then see that G unites with *s* to form a rejuvenated cell, which is the pristine embryonic cell. Theoretically C and *g* might produce a second cell; but in reality these elements perish, so that after fecundation, in place of two cells capable of further division, there is only one. It is clear that here an increase has no more occurred than in the case of the Vorticellæ. It would seem that the power of cells to increase by division is limited; then comes a moment when they can divide no longer unless rejuvenated by the process of fecundation. In animals and in plants the only cells capable of being thus rejuvenated are the ova, and the only ones which can effect this change are the spermacyts. All other parts of the individual are doomed to death. Fecundation is the condition of the continuity of life. By it (or in it) the generator escapes death. I have taught this hypothesis since 1876, and it finds new supports in the study of *Ascaris megalocephala*.

It would be interesting to examine whether a vegetable form could be produced indefinitely by cuttings without a slow decline setting in, or without the individuals becoming enfeebled [horticultural experience points in this direction]; whether a species can maintain itself in cases where fecundation does not from time to time interrupt the series of asexual reproduction.

By the hypothesis of the hermaphroditism of cells, parthenogenesis may be explained if the formation of the polar vesicles does not take place, or if these elements after their formation reunite with the female gonocyt. In the hope of finding this conclusion confirmed I suggested to the Natural History Section of the Belgian Academy, in 1876, to propose as a prize-question the enquiry whether in parthenogenesis the ovum evolves polar vesicles. It is certain that, in most cases in which parthenogenesis has been observed, this mode of reproduction alternates with fecundation, and it is probable that this takes place in all cases.

It is unnecessary to call attention to the bearing of these researches upon the questions of life, individuality, reproduction, and death. But we cannot help remarking that Prof. Beneden, in the words "Fecundation is, in its essence, substitution," points towards—if he does not fully establish—a connecting-link between chemical combination and organic fecundation. By so doing he confirms the great principle of continuity at a point where it has been called in question.

IV. REFORMS SUGGESTED IN THE MODE OF CONDUCTING THE CHEMICAL EXAMINATIONS, AND IN THE GIVING OF THE CHEMICAL EVIDENCE IN THE LAW COURTS, IN POISON CASES.

By Robert Galloway, M.R.I.A.

THE subject of the present paper is one of no ordinary importance, for upon the evidence of the analytical chemist engaged in suspected poison cases mainly depends the conviction or acquittal of the suspected or accused person. I entertain the opinion very strongly—knowing the possible lapses in Analytical Chemistry, even when analyses are conducted by experienced chemists—that the analyst should not be left so uncontrolled as he is at present in these very serious and difficult analytical examinations; and that he should not be allowed, in giving his evidence, to mix up medical opinions with the results he has obtained, whether affirmative or negative, in the investigation. I advocate these and other alterations of equal importance, and which I shall name presently, both in the interests of those who may hereafter be accused and in the interests of Justice; for whilst, on the one hand, no innocent person should be condemned, the guilty ought not to escape. This is no purely chemical question, interesting only to chemists and medical men; it is one which deeply concerns the public at large.

That mistakes have been made by analysts is an undoubted fact; the public generally must be even aware of it, for there has appeared not unfrequently in the public press an account of the proceedings taken in some court of law by traders who had been falsely accused of adulterating some article of food they vended, owing to the incorrect analysis of the chemist, the verdict they gained establishing that they were honest and not dishonest traders,—a matter of no small importance, although *life* or *death* did not depend upon the issue.

The analysis of milk is so comparatively simple that a properly trained analyst ought to make no mistake; yet in this article of food, as in others, mistakes have been exposed in courts of law. The means the honest trader has of clearing his character against the dishonesty imputed to him by the errors of the analyst arises from the safeguard which was introduced into the Food Adulteration Act. By one of the provisions in this Act the party procuring a sample of food from the vendor, to have it analytically examined in order to ascertain whether it is adulterated or not, must, after procuring it, inform the vendor for what object it has been procured, and the procurer must divide it into three separate samples,—one for the analyst who is employed by the local authority who has directed it to be procured; another for the trader, who may send it to be examined to any analyst he may choose to select; and the third is to be kept for submitting it to an analyst who is to act as a kind of umpire in case the trader's analyst—assuming he has employed one—and the analyst selected by the local authority do not agree in their analytical results. If it were not for this clause in the Act honest traders would seldom have an opportunity of righting themselves in the eyes of the public against the aspersions cast upon them by the analyst. This excellent provision is no doubt not always availed of by those who consider they are innocent of the charges made against them; sometimes, no doubt, owing to the poverty of the accused, at other times owing to their ignorance of the protection afforded them by the law; yet it is, nevertheless, a valuable provision, as it offers protection to the innocent, and is a restraint upon incompetent and careless analysts.

But in the still more serious charge of poisoning the accused have no such protection afforded them; in fact they have no means at all offered for defending themselves against the accusation, beyond the aid of a barrister in the law court; hence should the analyst find poison when none had been administered, it would rarely happen that the mistake could be disproved.

That mistakes have occurred there is great reason for fearing; that iron-rust stains have been mistaken for blood stains is known: in one case, I remember well, the accused —who was charged with poisoning by phosphorus—was acquitted owing to the skilful cross-examination the analyst underwent by the counsel employed on behalf of the accused, and this was due to the fact that this lawyer had studied Chemistry. And although the notorious Palmer was no doubt guilty, it was proved more from the symptoms produced by the poison on the dying man than from any poison being found in his body. If the records of the trials for poisoning were gone through they would fully prove, I believe, the necessity for the additional precautions for protecting the innocent I advocate. The alterations I would suggest are:—

1st. There should be a medical as well as a chemical expert employed, and each separate division—England, Ireland, and Scotland—of the United Kingdom should have its own two experts, and in each case they should be specially selected by the political chief of the proper Government department. No local authority—as corporations, grand juries, &c.—ought to be allowed to select an analyst even for a preliminary enquiry. The laboratory of a general analyst is not suitable for carrying out these serious and delicate analytical examinations; nor is the commercial analyst, with his *speedy* and sometimes not very *delicate* methods, in all cases exactly in training for these more exact and refined investigations. No other analytical work ought to be conducted in the laboratory in which the poison cases are carried on; the laboratory should not be entered by an assistant, or other persons, except when the expert was present; and the expert, when leaving the laboratory, should lock it up, and keep the key in his own possession.

2nd. The chemical expert should confine himself entirely, in his examination in the court, to the question whether he had found poison or not, and the methods he employed in the examination. He should invariably bring his note-book, containing a full report of the examination, into court, so that it might be examined by all the parties concerned in the case. It is usual at present for the analyst to give, with his chemical evidence, medical opinions: this must necessarily render his evidence most confusing both to the judge and the jury, especially as, in at least ninety-nine cases out of every hundred, both the judge and the jury will know nothing at all about Chemistry and Medicine; and it would be difficult, in most cases, to know where the chemical evidence ends and the medical begins, and how much importance is to be attached to the one branch of the evidence as compared with the other; and this is due, to no small extent, from the way the analyst generally mixes up and jumbles the two together.

Moreover, I contend that the analyst is not competent to give medical opinions, even if he has taken a medical degree. A medical man who confines himself to Surgery considers himself unfitted to act as a physician, and a physician considers himself unfitted to act as a surgeon, yet the surgeon and the physician are in practice; whereas the analyst, although he may have taken a medical degree, will not, if he practises Chemistry, practise as a medical man,—probably he has never seen any practice since taking his degree: he is therefore, I contend, incompetent to form and give medical opinions from his own knowledge and experience; they can only be the opinions he has obtained from books.

I will cite two examples as confirmatory of what I have stated. The late Professor of Chemistry in King's College, London (Wm. Allen Miller, M.D.), on being examined before a Parliamentary Committee on the water question, was asked what would be the effect on persons drinking water containing sulphate of lime? He replied that he was not competent to give an opinion on that subject. "Are you not a medical man?" inquired the Committee. "Yes," he said, "I have taken the degree of Doctor of Medicine, but I have never practised; I have therefore no experience to guide me in forming an opinion on the subject." In the Balham case the cousin (a surgeon) of the deceased man was asked in his examination some medical questions; he replied he was not able to answer them or to offer an opinion, as he was a surgeon and not a physician.

I may state that when, some years ago, I was offered by the Irish Government, through one of their legal advisers, the office of analyst in poison cases for a part of Ireland, I had to decline it from conscientious motives, although the fees I would have obtained would have added considerably to my income. I stated to the gentleman who offered me it that the evidence I would give would not conform with the evidence usually given in such cases, and therefore they might not approve of it, as I would confine myself entirely to the chemical part of the subject. I would not touch on the medical part in the slightest degree. Another reason was, I could not in my then position have a laboratory set apart solely for that purpose, and so entirely under my own control that no one else could enter it without my knowledge and permission, which I considered absolutely necessary for conducting the analyses and examinations with that extreme care which such cases imperatively demanded.

The medical expert would of course attend and take the leading part in the *post mortem* examinations; he would also be the adviser in cases where general practitioners were in doubt as to whether a patient they were attending was being slowly poisoned or labouring under the effects of poison. In cases where the chemical analyst found poison in the body, the medical expert would, in giving his evidence, have to state whether the appearances revealed at the *post mortem* examination and the symptoms of the dying person indicated the particular poison the analyst had found. In cases where the analyst did not discover any poison, the medical expert's opinion would have to be taken as to whether the medical examinations indicated poisoning, and, if they did, what particular poison.

3rd. As the Law very properly allows those who may be charged with adulterating any article of food they sell to employ an analyst to examine a portion of the sample the local authority, by one of its agents, has obtained for the purpose of ascertaining whether it is adulterated or not, so in the still more serious matter of poisoning the suspected persons ought—if they so desired—to have the power by Law of employing an analytical chemist to be present during the examinations the chemical expert made. For if a mistake were committed by the expert, which we have shown from analogous cases is not impossible, it would in most cases be impossible for the defendant's counsel to discover it, even with the aid of an analyst, no matter how skilfully he might cross-examine the expert.

It would not, however, be desirable to allow the accused power to select any person who chose to call himself an analytical chemist for this very delicate and responsible duty; but the political chief of the Government Department which had charge of these inquiries might name some chemists of eminence, in each of the three divisions of the kingdom, he would accept.

4th. But whether in future the Government will or will not allow—and especially if they will not allow—the accused to select an analyst to be present in the expert's laboratory during the time he is conducting the examinations, no chemist, no matter how eminent he may be, should be appointed as a Government expert without having first undergone a very strict practical examination in Analytical Chemistry, both qualitative and quantitative, and in microscopic work in relation to the detection both of organic and inorganic poisons.

One example will be sufficient to show the necessity for the candidates who are selected, or who offer themselves for the position of chemical expert, undergoing or being submitted to a practical examination such as I have indicated.

The tests for some of the organic poisons are *colour tests*,—that is, they are distinguished by the *colour* they give with certain reagents; therefore those who undertake the chemical examination for poison cases ought to be free from all *colour blindness*. Now I have found, in teaching Analytical Chemistry during many years, that a not inconsiderable number of the students I had to teach—and I have no doubt other teachers have found it to be the case with some of those they taught—were *colour blind;* they could not distinguish or see the *violet* colour potassium compounds impart to a gas flame, even when the colour was made more perceptible by cutting off, by absorption, other colour rays by viewing the flame through a glass stained *blue* with cobalt. This *violet* colour and the *yellow* colour sodium compounds impart to the gas flame were the chief ones the majority of the students had to distinguish: whether some of the students who were not defective in vision as regards the violet colour, and whether some of those who were, were colour-blind as regards other colours I am unable to say, as inorganic analytical chemistry does not afford a means of testing accurately the sight as regards other colours. But one case, a very extraordinary one, came under my notice. A gentleman, a medical man, came to study chemistry with me, and during the time he was with me he wished to go through a course of analysis for the detection of organic poisons. I found out early, after he commenced this course, that he would—on account of his defective sight as regards colours—be unable to acquire *accuracy* in this branch of chemical analysis, for he was *colour-blind* as regards most of the colours.

If it could be ascertained, I venture to say that it would be found that our Government authorities have never ascertained, before allowing an analyst to act as a chemical expert, whether he was free from colour-blindness; yet in this one particular alone my readers will see how important it is that those who are appointed to discharge the duties devolving upon a chemical expert in poison cases should be free from even this one defect.

5th. There is yet one other point deserving of notice. At the present time much of the analytical and other laboratory work is not performed by those to whom it is entrusted, but by their assistants; sometimes by students, and even laboratory porters, it is said, sometimes take part in it: nay, more, when even the brain-work as well as the manipulative skill of some of the papers contributed to our learned scientific societies—as the Royal—is not the work of the one whose name it bears, but is the work of others who do not appear *on the stage*, it is necessary, in the interests of the accused and also in the interests of Justice, that the expert should not be allowed to hand over any of the analytical examination in poison cases to another party; he ought to be examined on oath whether he had performed the entire examination himself.

From some observations our present Secretary of State for the Home Department, the Rt. Hon. Sir Wm. Vernon Harcourt, made in the House of Commons some time ago, he appears to be opposed to any alteration in the present mode of conducting poison cases; but if Sir William knew as much about Analytical Chemistry as he knows about Law, I think he would be inclined for at least some reformation in the present system.

V. VARIABLE STARS.

By J. R. Sutton.

IN the constellation of Perseus is a star which is known to astronomers as β Persei, otherwise Algol. Ordinarily this star is of the second magnitude; but if it is attentively watched it will be observed to undergo some rather remarkable changes. There are times, which from the regularity of their frequent occurrence can be readily calculated beforehand, when its light undergoes a gradual diminution, passing from the second to the fourth magnitude in about 3½ hours, remaining at the fourth magnitude for about twenty minutes, and thence passing in another 3½ hours to its normal brilliancy, at which it remains for some 61 hours, the whole period occupying some 70 hours in its completion.

Several theories have been put forward to account for the strange phenomena which this star exhibits, but hitherto, as it seems, without much success. We shall examine them one by one, although some of them will not call for more than a cursory notice.

We may reject at the outset the supposition that Algol is of an irregular shape, and therefore presents, in consequence of his rotation, some parts of his surface at an ever-varying angle to the earth, the brilliancy being greatest when the greater portion of the surface is square to the line of sight. And the same reasons which enable us to reject this, enable us also to cast aside the idea that one side of Algol is brighter than the other. For it must be abundantly clear that if we suppose Algol to be in a sun-like condition, he must be surrounded—as other suns are—by an elastic gaseous envelope possessing light and heat-giving properties. It follows, then, that in the first case the tendency of these clouds would be to spread themselves over, and obliterate from sight the irregularities upon the surface of this star; whilst, in the second place, it must be regarded as next to impossible that one portion of a star's surface should be in a different condition to another, and remain so for a very long period. In all questions such as this analogy is our safest guide; and if we look upon Algol as a sun like our own, we must rather infer that the mighty forces which are necessarily in ceaseless action throughout his whole globe would tend to fully equalise the light and heat-giving power of his whole surface. Moreover, Prof. Young has indicated reasons for the conclusion that the sun's nucleus is not solid, but that, in all probability, it is in a nebulous state throughout,—a consideration which if admitted would, obviously, completely negative, upon analytical grounds, either of the above theories.

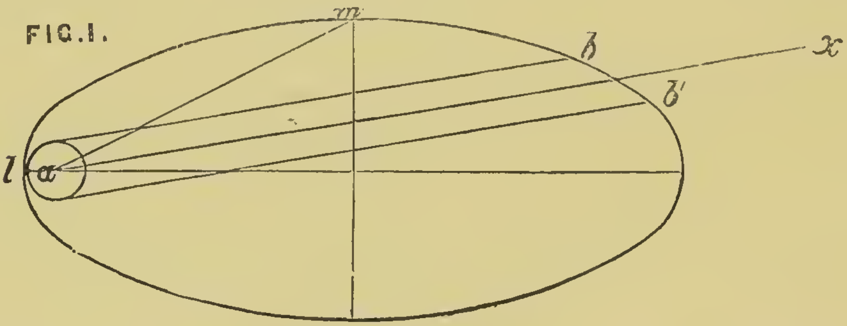
I pass, also, the sun-spot theory—the theory, namely, that sun-spots of large dimensions check the emission of light from the surfaces of the different variable stars, the observed effect being caused by the star's motion of rotation. So far as Algol alone (or indeed any other star whose maxima and minima of brightness occur with an unbroken regularity) is concerned, a theory such as this is but the re-statement, in a slightly modified form, of the theory that one side of Algol is brighter than the other. We have yet to learn that any disruption on the surface of our own sun could last unchanged for a very long period.

In like manner Prof. Balfour Stewart's suggested possibility must be dismissed as unfounded upon fact. "We are entitled," he says, "to conclude that, in our own system, the approach of a planet to the Sun is favourable to luminosity, and especially in that portion which is next the planet. Let us consider variable stars. Now if we suppose such a star to have a large planet revolving round it at a large distance, then, according to our hypothesis, that portion of the star which is near the planet will be more luminous than that which is more remote; and this state of things will revolve round as the planet itself revolves, presenting to a distant spectator an appearance of variation, with a period equal to that of the planet. And if we suppose a planet to have a very elliptical orbit, then for a long period of time it will be at a distance from its primary, while for a comparatively short period it will be very near. We should, therefore, expect a long period of darkness, and a comparatively short one of intense light, precisely what we have in temporary stars." This theory is, of course, possible, albeit somewhat deficient in analogous probability; but it must be borne in mind that a spectroscopic examination of one of these temporary stars has most conclusively proved that its sudden accession of brilliancy was caused by an outbreak of glowing hydrogen; and we have yet, I apprehend, to find that the periodical increase and decrease in the light of Algol is caused by a conflagration of any substance whatever. Moreover, it seems somewhat hazardous to maintain that a planet's influence could generate changes of light to such a degree, even if it could affect it at all, changes which would most obviously suggest an excessive influence over the physical condition of the whole system of which it formed a part.

Much more worthy of consideration is that theory which assumes each star to be the centre of a system of revolving worlds which in some instances pass in the course of each revolution, between their primary and the earth. We are upon safe ground here, for everything leads to the inference that other worlds do exist upon which intelligent beings may exist to utilise the metals, &c., which we know to have a place in their system as they do in ours.

Now let us, still keeping chiefly to a consideration of the star Algol, endeavour to find a theoretical satellite which will account satisfactorily for the periodic changes which its ruling sun exhibits. We will, in the first place, assume that his mass and volume are equal to the Sun's. Now Algol effects his complete cycle of changes in 69·83 hours approximately; consequently our planet must make one complete revolution in that time. Wherefore, by our supposition as to mass and volume, a planet to revolve once in 69·83 hours must travel at a mean distance from Algol's centre of about 3,670,000 miles. But Algol undergoes a more or less diminution of light for nearly eight hours; therefore our planet, when in transit, must travel over a space equal to the diameter of Algol in that time. It follows, then, that at the time the planet is travelling with a velocity of 30 miles a second; consequently its orbit cannot be nearly circular, for so as to travel in a circular orbit at a distance of 3,670,000 miles would require a velocity of 91 miles per second, or fully three times the observed amount! Then, because its velocity when in transit falls short of the velocity necessary for a circular orbit, its orbit must be an ellipse with Algol in one of the foci. Fig. 1 represents an orbit which would do. In this figure the lines parallel to *a x* represent the direction in space of the solar system; the planet travelling along *b b′* when in transit at a distance from Algol's centre of about 6,500,000 miles, passing at each return close to the latter's surface. And since the mean distance *a m* is 3,670,000 miles, and *a l* about 450,000 miles, the planet at its greatest distance must reach to nearly 6,900,000 miles from the ruling focus.

FIG. 1.



We see, then, that given the above data it is a comparatively simple matter to deduce a theoretical planet whose motions will accord with the fluctuations in the light of its primary. But we have omitted one element which creates a serious difficulty. It is this: the maximum light of Algol bears to its minimum the proportion of something like 5 to 1; and this is a consideration which seems to me to completely negative the satellite theory.

Let us pause to inquire into the conditions of this new feature in the problem.

Algol when at his brightest is shining with a light which call 5. At his extreme of loss of light he shines with a brilliancy which may be represented by 1. Then, *ipso facto*, he has lost four-fifths of his photometric effectiveness. Now a planet to cut off this amount of light must, supposing (as we may) that it is utterly opaque, have a diameter which would bear to the diameter of Algol the proportion of about 8 to 9. Or, by our assumption as to the mass and brilliancy of Algol,—*i.e.*, that it equals the Sun,—the planet must have a diameter of nearly 770,000 miles. These figures would, perhaps, require some modification for a thoroughly exact computation, since, in all probability, the greater portion of the light of Algol, as in the case of the Sun, comes from the centre of that portion of his disc which faces us. I have preferred, however, to leave them untouched, because the planet need not necessarily cross the star's disc centrally.

Taking these figures, then, to be correct enough for our present purposes, we arrive at some rather strange consequences;—(1) Either these two orbs are formed of different materials; or (2) one has in some way been able to retain its heat, while the other has parted with its heat in the ordinary course of nature; or (3) the density of the brighter of these is far in excess of that of the opaque body.

Now let us consider the *à priori* possibility of these instances *seriatim*. We shall, I think, as we proceed, perceive how unsafe it will be to put our confidence in a theory which is so utterly at variance with everything that analogy teaches us.

With regard to (1) it should be clearly understood that we have not the least reason to suppose that two bodies in one system should differ in their component elements. In the Solar System, from the fact that the Sun is constituted of similar materials to the Earth, we infer that the planets possess these materials also. And this view is further strengthened by the circumstance that Mars and Venus exhibit certain indications of air and water upon their surfaces, giving a yet closer sign of universal relationship in the planetary scheme. Any element such as iron or gold need not, of course, exist in the exact proportion to a planet's mass: but the disproportion, whatever it is, must be very small, so that we shall be quite within due bounds in assuming all the planets in the Solar System to be formed similarly. Most assuredly, therefore, we should not be justified, without strong positive evidence, in concluding that different laws have been in course of enactment out yonder in the star depths.

The same reasoning, of course, applies to the statement under the second head. Unless the two bodies are differently constituted, how are we to suppose that one managed to retain its internal heat long after the other had become cold and without brilliancy? All our knowledge goes to show that heated bodies of similar constituent elements—be they planets, rocks, or anything whatever—pass through their stages of cooling under a settled law and at a settled rate. We will, by way of example, illustrate this law by comparing the Earth and Moon. The Earth contains 81·5 more gravitating matter than the Moon; but its surface is greater than the moon's in the ratio of 13½ to 1. Therefore, assuming them to have started upon their separate existences at the same time and at the same temperature, the Earth would part with its heat 81½ times slower in virtue of its mass, but 13½ times faster by reason of its greater extent of heat-radiating surface. By combining this proportion we shall see that the Moon would take scarcely one-sixth of the time to pass through its respective stages as would the Earth. This rule must obviously be modified somewhat when we compare bodies such as the Earth and Sun, because the greater power of the Sun would gather more external matter from the outer space to feed his decaying energies than could be possible for the Earth, so that the Sun would take, proportionately, far longer to cool than the much smaller Earth, in consequence. But Algol and its theoretical satellite are, as we have seen, so nearly of a size that they ought practically to pass through their respective stages of cooling in an equal time.

The fact, however, above stated, that bodies cool, generally speaking, under a settled law, is fatal to statement (3) also. So long as the heat of the larger orb is greater than than that of the lesser, so long will it be impossible that the mean density of the larger should be greater than the density of the smaller, *unless*—unless we re-admit some such subsidiary hypotheses as those which we have just shown to be unsound. We may, in fact, take it as a general rule that between any two orbs of equal size the density of one would be greater or less according as its internal heat was less or greater than its neighbour's.

In applying the above considerations to Algol and its theoretical planet, we shall not fail to be struck with the fact that the opaque orb must have parted with its heat at a much more rapid *rate* than the brighter, unless some accidental collision on a vast scale vapourised Algol without affecting its planet, which contingency must be regarded as of a vastly remote possibility. If we assume, for argument's sake, that the Sun, when he has parted with his heat, will have a mean density equal to the Earth's (a very moderate estimate, since it will probably exceed it many times), its mass naturally remaining the same, we shall see that his volume will have to contract into a space occupying only one-fourth of that which he now occupies. Consequently if the satellite of Algol equals the Earth in density (as we have seen, a very low estimate considering his size), and Algol itself in density equals the Sun, we arrive at the happy result that the centre of the heat, life, and light of the system of β Persei is a secondary body in its own system,—since its mass must be much less than that of the opaque orb,—a state of things highly adapted to the philosophy of the Ptolemaists.

If it were worth while, it would be easy to deduce a circular, instead of an elliptic, orbit for the system of Algol, with mass and diameter to match. Such an inquiry, however, would be without value, since it would leave absolutely untouched the arguments urged against the third postulation. Whatever the size or shape of the orbit, or whatever the size of Algol, the opaque body would still bear the same proportion, namely as 8 is to 9, to Algol itself.

Another celebrated variable is Mira, of the constellation of Cetus. This star passes through its cycle of changes in a little over 331½ days. Unlike Algol, which is normally at its brighest, Mira is only at its maximum of brilliancy during a period which bears a very small ratio to its period of minimum. Furthermore, its variability is not so regular as that of Algol. Its greatest brilliancy is not always of equal intensity; but, at the same time, it is supposed that the different effects occur with periodical regularity, and are only minor variations of the great cycle of changes.

Manifestly none of the above theories explain the changes of this star. Even the satellite theory, the most probable of them all, would require, it would seem, bodies whose motions should be altogether independent of the laws of gravitation. Any planet, or number of planets, to effect the observed changes, would have to rush hither and thither at times, in a highly erratic manner, to the not small danger of the whole system the while; but settling down calmly, for about five months, in such a position as to cut off nearly every particle of the light which Mira sends to the Earth.

We see, then, that every theory yet propounded is defective, insomuch that, although they may be successfully applied in special cases, they fail utterly in reconciling themselves with the nearly similar occurrences in other stars.

There is a theory, however, by which *all* the phenomena with which I have dealt may be explained in a very simple manner. And not only has the theory I am about to propose the merit of explaining them satisfactorily, but it is founded wholly upon arguments drawn from analogy. And further, it shows also the sudden appearances of "temporary" stars, and the changes—whether regular or irregular—which the variable stars undergo, to be due to the different workings of one cause.

But it will be necessary, before proceeding, to notice briefly the appearances which some of these temporary stars have presented.

I take first the celebrated star of 1572. This star was first observed by Tycho Brahé. It seems to have flashed suddenly into existence, shining with a light which was comparable to that of Venus in quadrature; indeed for a considerable time it was visible in full sunlight at noon. It faded very rapidly, however, and finally disappeared, having been visible for very nearly seventeen months. It may be that this instance was but the reappearance of a variable star of long period; for upon previous occasions temporary stars have been observed near this spot. The evidence is of too frail a character, however, to warrant any definite opinion.

The only other instance which I shall use is that of the outburst of a star, in the year 1866, in the constellation of Corona. This appearance was noteworthy because a spectroscopic examination conclusively showed that its sudden accession of brilliancy was caused by an outbreak of hydrogen, making it, as Proctor remarks, fully 800 times brighter than it now is. Like the other, this star gradually faded, the hydrogen apparently cooling at the same time.

Both these stars were situated close to the Milky Way. We shall see presently that this circumstance is highly significant.

Now it seems to me that if we regard all the changes which take place in the light of the celestial orbs to be caused by meteors, we shall have made a decided advance upon former theories. Take first the case of Algol. If, instead of assuming that this orb is circled by a planetary orbit of the proper eccentricity, we assume that he is surrounded by extensive meteor systems, we have, certainly, a thoroughly practical and analogical way of escape from the difficulties in the way of the former supposition. Now every star must be the ruler of more or less extensive meteor systems, although every star need not be so situated that the chiefest of these pass once in a revolution between itself and the Solar System. Algol, indeed, from his position, may fairly be deemed as occupying a position which would in a high degree enable him to collect into his system vast quantities of these tiny servitors. He is situated close by the Milky Way. Now if certain reasons which I have quite recently advanced elsewhere are valid, we must conclude that the Galactic Zone is crowded, more than any other portion of the heavens, with bodies of all sizes, from the mere atom to the mighty Sun. And it follows that the latter must subject to their sway much of the former matter. Our own Sun, though not situated within the Galactic Belt, is yet fairly off for meteoric attendants; and how many more should those stars more favourably situated possess? It is all but certain that the leading brilliants of the Milky Way are surrounded by enormous quantities.

Let us now suppose our November Meteor System to be vastly recruited, especially in its richest portion, or in "the gem of the ring" as it is termed. Then we can see that, to an observer situated far out in space upon the produced plane of the orbit of the November meteorites, the passage of the gem of the ring across the Sun's face, would cut off a considerable portion of the Sun's light—quite as effectively, in fact, as would the disproportionate planet, which the other theory requires. The figure which we have deduced for the planet's orbit would make an excellent orbit for a meteor system; it is, indeed, far more meteoric than planetary in form. It only remains to add that the total mass of a meteor system, to produce the observed diminution in the light of Algol, need only be a very small fraction of what would be necessary for a planet.

Now at first sight it might appear that, although we have here a ready explanation of the variations of Algol, we are not so fortunate when we come to apply it to the case of Mira. As we have said, this star is invisible to the naked eye during five months of the year; and it would be too much to ask us to believe that during all this time meteors are passing between this star and the Earth. Such an assumption would be almost as absurd as the satellite assumption. But we must be careful to distinguish between the varying conditions under which meteors are ruled by the central Sun. The problem presented by half a dozen meteoric orbits, for example, would be vastly different from that presented by one or two hundred of such orbits. If the variability of Mira is indeed caused by these minute bodies, then, undoubtedly, she is surrounded by systems much more extensive than the Sun's, or those of Algol, although we may not fairly believe that she is surrounded by sufficient quantities to cut off the observed amount of her light. Now for our present purpose it matters little whether we regard Mira as a very small orb, comparatively, or as situated at a vast distance from the Earth. In either case her observed brilliancy could be explained. And in either case, if we assume that she is surrounded by a large number of dense meteor systems, we are provided with an assumption which enables us to explain even the variations of her variability.

We are almost certain that a considerable part of the Sun's heat and light is maintained by the impact of quantities of meteors upon his mass. But obviously, unless these bodies existed in large quantities, they could not do more than assist in maintaining his heat and light. For it would be necessary, before they could reach his surface, that they should, in some way, be pulled up short in their orbit, so as to be forced to fall by attraction upon the Sun's globe, since a body travelling in an orbit would never fall upon the Sun unless brought first almost or quite to rest, and there is not any way of bringing a moving body to rest save by collision with other bodies. From which we easily deduce the fact that the greater the number of meteor systems the greater the chance of collisions, and, *à priori*, the greater the quantity of matter which would eventually reach the Sun's surface, and, therefore, the stronger the emission of light. Furthermore the periodicity with which Mira goes through her minor changes could be explained as due to the fact that the density of the matter in each individual meteor ring is different in different places, precisely as in the November meteor system. In which case we can readily see that the amount of matter in her immediate vicinity and suitably placed for collision must vary accordingly.

We have, perhaps, in the rings of Saturn an instance of the approach of small bodies to the ruling centre in consequence of their private encounters. If the observations are to be trusted, these rings have been changing in detail and increasing in width ever since they were first measured. But the strongest evidence in favour of the theory I am advocating may be drawn from the changes in the brilliancy of the star η Argûs. This star is situated in the midst of a nebula, and, without doubt, vast quantities of matter must be in a continuous state of commotion therein, the effects of which are observable in the un-uniform and erratic changes which η Argûs undergoes. It has vied in brilliancy with Sirius, although there have been times when it has been scarcely conspicuous upon the background of the sky. At the same time it is necessary to remark that opinion differs as to whether the star is really within the nebula or dissociated from it. The question will never, probably, be directly determined, although it seems difficult to examine Herschel's drawing of the nebula and then conclude that the stars in the same field are merely superposed upon it. If the star is in the nebula, my view is, of course, greatly strengthened; if it is not, the theory cannot be regarded as thereby weakened appreciably. All that need be said is that the changes of η Argûs are of better probability when ascribed to a meteoric origin than as a planetary phenomenon, and that its position would seem to supply the clue as to the source from whence its energy is derived.

Accepting the meteoric theory as true, we may divide the stars into three classes as follow:—

α. Those whose meteor systems are fixed, and not subject to any considerable changes. To this class belong the Sun and Algol.

β. Those whose meteor systems have definite orbits, but of such a richness that a considerable quantity must from time to time fall upon their sun's globe in the manner described above. To this class belong such stars as Mira and η Argûs, which possibly represent a state of things through which our own sun has long since passed.

γ. Temporary stars.

Upon this theory the phenomena of temporary stars could be considered as caused by an accidental collision in space between the matter of which the Milky Way is largely made up and the stars whose sudden appearances have from time to time astonished the world of science; or, in short, that variable stars represent the manifestations of purely local movements, whilst temporary stars point to the action of matter foreign to their systems. Moreover, the stars themselves are in motion, and it only requires that themselves and the matter with which they collide should be travelling in the right direction to ensure a collision. Nor must it be forgotten that the Solar System is liable to the same catastrophe, which, if it ever occurs, will most certainly sweep every vestige of life from the surface of the earth. But, comparing the Sun's position in space with those suns whose light reaches us from the depths of the Galaxy, and, further, taking into account the rarity of the occurrence even among the latter, we may rest confident that the *chance* of our destruction from this cause alone is very small; so small, in fact, that we shall be quite safe in concluding that our planet will have a very long lease of existence indeed.

VI. THE LATERAL LINE OF FISHES.

By M. G. de Séde.

It is familiarly known that the name of "lateral line" has been given by ichthyologists to an organ which runs along each side of almost all fishes, extending from the head to the tail. It has been successively studied by Steno, Lorenzini, Petit, Redi, Leydig, and Schulze, the latter of whom have indicated the true path to be followed for the discovery of the functions of this line, whilst they have almost completed the investigation of its anatomy.

M. de Sède, in a thesis recently maintained before the Faculty of Sciences at Paris, and reproduced in "Cosmos les Mondes," gave an account of certain interesting experiments made for the purpose of elucidating the physiological function of this curious organ.

The fishes selected for the experiment were first submitted to the action of an anæsthetic, and then underwent the operation of re-section of the lateral nerve, which excited no reflex action due to pain. When resuscitated the subjects were left at rest in a large bowl, and some days afterwards they were placed in a vast aquarium where everything is so arranged that a fish desirous of circulating freely must make use of all its tactile resources and means of guidance. Under these conditions it was observed that the fishes which had been operated upon moved only with great caution, and were almost always the last to arrive at the distribution of food. Thus it appears that a fish able to make use of its eyes, but deprived of its lateral line, experiences a certain difficulty in finding its way.

M. G. de Sède next sought to ascertain how a fish would act if it retained the use of its lateral line, but was deprived of sight.

Two perches were blinded by removal of the eye-ball. There remained to them, then, for guidance, merely the general sensibility of the integuments and the special impressionability of the lateral apparatus in question. These organs acquire in a short time a great delicacy, for the two perches when placed in the general aquarium were soon able to guide themselves without any difficulty.

But the question now arises as to what part of this steering-power belongs to the general sensibility, and what to this lateral line? Further experiments solved this problem.

A barbel was blinded, and, by way of extra precaution, its filaments were amputated. Subsequently its lateral nerve was severed. As long as this fish—even though deprived of its eyes and beard—retained the lateral nerve it guided itself easily; but as soon as this nerve was severed it remained persistently motionless.

Lastly, a perch, blinded and deprived of its lateral line on one side only, was placed in the labyrinthine aquarium. It contrived to keep the non-mutilated side turned towards any obstacle,

These experiments leave no doubt as to the function of the lateral line.

It is a very delicate organ of touch, adapted to the requirements of an aquatic life. It is sensitive to the faintest movements of the water, takes cognisance of the slightest displacements, and gives fishes continual information on the state of the medium in which they live.

LUMINOUS PHENOMENON ROUND THE SUN.

HERR J. G. WALTER, of Bremen, writes thus to the Editor of the "Naturforscher":—

"The memoir of M. Forel, in your paper of October 11th, concerning Luminous Appearances round the Sun, leads me to communicate my own observations on this phenomenon.

"After the intense evening red of last winter had ceased, and whilst nothing remarkable appeared in April and May, I remarked in June daily here, in Bremen, a yellowish brown halo round the Sun. During July, August, and September

I saw the same appearance in Switzerland, and drew to it the attention of many persons with whom I came in contact. The phenomenon was most striking about noon, in a pure blue sky, but was also distinct through gaps in the clouds, which then took an ugly leaden grey colour. On the mountains the colour was strongest, but was quite distinct in the valleys. In the last few days it is still visible, though faintly.

"As a landscape-painter I am accustomed to observe closely the shades of colour of the sky and of the clouds, and have been the more surprised at witnessing something which, to my knowledge, has not occurred for fifty years at least. As M. Forel asserts, the kind of weather—as warm or cold, wet or dry—has no connection with this phenomenon.

"I saw that the highest summer clouds, far above the peaks of the Alps, were still far beneath this phenomenon. Further, the colour of the Moon was quite unaffected, which makes me inclined to seek for the cause beyond the orbit of the Moon, and probably nearer to the body of the Sun. But before indulging in conjectures we must first know whether this luminous phenomenon has been seen all over the world, or at least in extra-European countries. It would also be desirable to know whether spectroscopic observations have thrown any light on the nature and the distance of the still mysterious matter. It is difficult to conceive that any terrestrial dust, smoke, mist, or gas can have remained so long (fifteen months) in the same position in our atmosphere."

ANALYSES OF BOOKS.

Transactions and Proceedings of the Royal Society of Victoria. Vol. XX. Issued May 30th, 1884. Melbourne: Mason, Firth, and M'Cutcheon. London: Williams and Norgate.

Among the papers here inserted in full we find two on the Influence of Light on Bacteria, the one by Dr. A. Downes and T. P. Blunt, F.C.S., and the other by Dr. James Jamieson. These memoirs form part and parcel of a controversy. The two first-named authors communicated to the Royal Society of London the results of an investigation from which they inferred that light is hostile to the development of bacteria, and probably to unprotected protoplasm in general. Dr. Jamieson objects to this conclusion, and attributes the effects observed not to light but to heat. Messrs. Downes and Blunt, in the paper here inserted, uphold their former inference, whilst Dr. Jamieson concludes, from further experiments, that the brightest diffused light is not inimical to the development of bacteria, and that full exposure to the sun's rays is not destructive to bacteria or their germs if guarded against exposure to too great heat. He admits, however, that development may be retarded.

Mr. James Stirling, F.L.S., contributes a paper on "Caves Perforating Marble Deposits," at Limestone Creek. The temperature of these caves is about 50° F., which is about the mean annual temperature of the district which lies at 3000 feet above the sea level.

Mr. T. S. Ralph discusses the occurrence of bacteria (bacilli) in living plants. Such bacilli have been previously noticed in the tissues of decaying plants, but the author has recognised them in the living cells of an apparently healthy Vallisneria, and also of *Anacharis alsinastrum*. He raises the questions: "What relation do such bacilli bear to the plant in which they are found? Are they vegetals living in commensalism with it? Are these organisms vegetal or animal in their life character? Do they await the dissolution of the cell contents in order to complete further destructive changes? Do they conduce to the zymotic changes of the chlorophyl and starch-grains occupying the cells in which they are found?"

Mr. P. H. MacGillivray, F.L.S., contributes two pages in continuation of his description of new or little-known polyzoa.

The rest of the papers, with the exception of Mr. Ellery's notes on the Rainfall Map issued by the Government of Victoria, contain little or nothing which might not have been worked out fully as well in Europe. What the world naturally expects from the colonial learned societies is research concerning local phenomena—meteorological, geological, and, above all, biological.

Exercises in Electrical and Magnetic Measurement. By R. E. Day, M.A. London: Longmans, Green, and Co.

The work before us owes its origin to the increased attention paid to the study of electricity and magnetism. The author enters upon his task with an explanation of the units now employed in electrical measurements. It may be that the names of eminent physicists have furnished the most convenient designations for some of these units. But we should not like to see the principle extended. It would sound strange if we were to hear a certain quantity of hardness in water spoken of as a " Clarke "—a standard " previous sewage contamination " described as a " megafrankland."

After this preliminary explanation Mr. Day gives in succession problems illustrative of electrostatics, of the tension balance, of statical induction, the guard-ring electrometer, electrical discharges, moments of tension and inertia, magnetism, resistance, and conductivity, branch circuits and shunts, currents in simple circuits, currents in branch circuits, the special grouping of cells, volta-meters, and electrolysis, and the chemical theory of electromotive force, thermo-electricity, battery resistance, electro-motive force, electro-magnetic measurement, magneto-electric induction, and the distribution of heat and work.

When used in connection with actual laboratory work this treatise will be found exceedingly valuable.

Longman's Magazine. No. 25, November, 1884. London: Longmans and Co.

The article which claims our attention in this number bears the title "Honey Dew," and is a study by Mr. Grant Allen, of aphides, especially in their relation to ants. Execrable as the former insects are, there is much in their economy which is highly interesting. In no respect do the ants appear more decidedly as enemies to man than by fostering and defending plant-lice. It has occurred that when a tree has, with great labour, been freed from these vermin, the ants have introduced a fresh colony. So that to clean a rosery or an orchard it is necessary to begin by treating the ants to liberal doses of corrosive sublimate, carbolic acid, and where they have formed large nests, petroleum.

Mr. Allen ventures the surmise—by no means improbable—that the species of insects kept in a kind of domestication by ants have been "produced by the ants themselves exactly as the dog, the sheep, and the cow in their existing types have been produced by deliberate human selection." He quotes the observation of Sir J. Lubbock that the late autumnal eggs of aphides, laid on the food-plant of these insects, are fetched under cover by the ants and carefully preserved till spring, when they are taken out.

A reflection, which, if not original, deserves to be had in constant remembrance, is that "whilst we can easily exterminate large animals such as the wolf and the bear in America, or the puma and the wolverene in the settled States of America, we should be so comparatively weak against the Colorado beetle or the fourteen years locust, and so absolutely powerless against the hop-fly, the turnip-fly, and the phylloxera." One reason may be that inventors prefer devising new means for the slaughter of their fellow men, such as explosives, "aërostats," submarine boats, &c.

Among the enemies of aphides Mr. Allen enumerates the lady-birds. He overlooks the Telephori, or as they are called by children in some parts of England, soldier- and sailor-beetles. These are far more active and voracious than the lady-birds, and in some seasons even more common.

Among vegetable remedies he enumerates tobacco—which is very efficacious—quassia and aloes, but makes no mention of *Pyrethrum roseum.*

CORRESPONDENCE.

, The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

THE SENTIENT EYE THE ONLY COLOUR BOX, AND THE BRAIN (*ENCEPHALON*) THE ONLY "*KNOWLEDGE*" BOX.

MAY I be permitted, with all due brevity, to direct attention to a contribution of Mr. Cave Thomas, with the first part of the above title in "Knowledge" of this week (12th December)? It entirely corroborates, so far as the *pseudo* external universe goes, the principles advocated in the fearless pages of the "Journal of Science" for some years back, under the terms Hylo-Idealism, Solipsism, Autopsism, Egoism, and *alia multa*. It conflicts, on the other hand, *in toto* with the theologistic article, quite on the lines of the defunct "Bridgewater," and Sir John Herschell's, treatises by Mr. Proctor, in the same number of his valuable serial, headed *Science and Natural Religion*. I quote below, with just economy of space, one or two of perhaps not the most salient sentences in Mr. Thomas's most suggestive communication:—

1st. The eye is the real seat of Light and Colour, their externality being a false misleading fallacy, founded on the dead Newtonian theory.

2nd. The light within us [he might have quoted Christ: "The light of the body is the Eye"] is not only a Bible metaphor, but a literal *scientific* truth.

3rd. That which is perceived by our *sensorium* [therefore the whole "objective" universe] is merely a property *or change of condition in our nerves.*

4th. Every fact shows Light and Colour and Sound [and all other sensations] to be innate endowments of our nature [anatomy], which merely require a stimulus for their excitation.

5th. This admitted, the whole science of Chromatics [he might have said all human Agnosis whatever] requires reconstruction,—lingering now in the sloughs of error from false hypotheses.

6th. Even a congenitally blind person has a perfect inner conception of Light and Colour, provided his optic nerves be sound.

7th. *This fact is admitted by all thinkers on the Continent, and by a few thorough scientists in England* [in our day the model Philistia].

8th. *It is a fact of which it has always appeared to me metaphysicians* [abstract thinkers] *might have made much.*

So far Mr. Cave Thomas. For very many years past I have done my best and worst to fulfil his last cogent scientific postulate, which lands us not in Theology or Theism, but in pure The-anthropism. It realises in Humanism the idea comprehended in Theism. It effectually checkmates all divine worship and ritual by showing the impossibility of transcending Manhood, and ultimately *Self*hood. All religions, natural or revealed, thus disappear, their successor being Hygiene, defined by Dr. Parkes as "supreme culture [physical] of mind and body."

ROBERT LEWINS, M.D.

Army and Navy Club, December 14, 1884.

"ARSENICAL DOMESTIC POISONING."

MY attention has been called to a leading article entitled "Arsenical Domestic Poisoning," which appeared in the "Medical Press" of November 12th.

In this article the writer refers to mine "On the Properties and Manufacture of Emerald Green," which appeared in the "Journal of Science" for August. The writer states I must have been sadly unobservant of what has been going on in the medical world as to the injurious effects of arsenical pigments in domestic fabrics. The only arsenical pigment I treated upon in my article was Emerald Green, and I stated, from *personal knowledge*, that the employed in an Emerald Green factory I was connected with for some time did not suffer from arsenical poisoning: it therefore appeared to me a correct conclusion that, if persons who inhabit rooms the wall-paper of which is stained with Emerald Green suffer from arsenical poisoning, the effects of homœopathic doses of this substance are different from its effect in large doses.

In the reported medical cases that have come under my notice, in not one single case has the medical man eliminated all sources of error before arriving at the conclusion that his patient was suffering from arsenical poisoning. No inspection as to the discolouration of the wall-paper, no chemical examination of the air in the rooms, to ascertain whether it contained arsenic, either in the form of arseniuretted hydrogen, or arsenious oxide, or emerald green have been made; and until these examinations—especially the last—have been made, and the results are affirmative, the medical writer must forgive me if I remain sceptical as to the poisonous effects of wall-paper when stained with Emerald Green.

ROBERT GALLOWAY.

"THUNDERBOLTS AND THUNDERSTONES."

THE term Thunderstone is not very frequently in use in the present day. The term Thunderbolt *is* very frequently used, and is applied to the lightning-flash when there is explosion or a crash. I have not heard it applied to any form of iron-pyrites, but it is a name very generally given to certain fossil remains found in gravels from the chalk, greeensand, oolite, and lias. They are of a cylindro-fusiform shape, and are the fossilised pens of cuttle-fish (Belemnitidæ). Those from the lias, on being fractured, emit a strong sulphurous smell. The material is carbonate of lime.

HENRY H. HIGGINS.

Rainhill.

NOTES.

Bestiarian Doings.—We borrow the subjoined paragraph from the "Medical News and Circular":—"It is hardly necessary for us to say that the anti-vivisectionists do not stop at equivocation or even at deliberate lying in their desire to influence public opinion. Two of them have, we are glad to say, been brought to book. One Ernst Weber has recently been sentenced to eight weeks' imprisonment for having in the journal of which he is editor published, under the heading "Vivisection of a Man," a statement that about eight years ago a Jewish physician had made a post-mortem examination of a man while only apparently dead, and therefore had performed vivisection on him. Dr. Pelz, who had performed the post-mortem in question, summoned him before a court of justice, with the above result. A clergyman of Munster, also, who was the author of the article, was sentenced to six weeks' imprisonment." The Ernst Weber here mentioned is doubtless the "knight of high orders," author of "Die Folter-Kammern der Wissenschaft," the text-book of German Bestiarians. For proofs of his former regard for truth, the reader is referred to "Wider die Humanaster," by Professor Goltz, reviewed in "Journal of Science (1883, p. 552).

M. J. C. Van Beek (*Archives Neerlandaises*) holds that the changes observed in the filtration of water or of dissolved or finely-divided matter through fibrous membranes under the influence of pressure, or of a prolongation of the experiment, are due to changes in the distance of the fibres constituting the membrane. Hence it is irrational to extend the results thus obtained to the exudation of a liquid through the coats of the blood-vessels and the capillaries.

Dr. Myers, in Surgeon-General Gordon's "Epitome of the Reports of the Medical Officers to the Chinese Imperial Maritime Customs' Services," testifies that opium-smoking does nothing like so much harm as alcoholic drinking.

"Soisom," writing in "Cosmos les Mondes" complains that "the efforts made to destroy the study of the Latin language because it is ecclesiastic destroys a bond of union among the nations which would have gone on increasing." [The efforts made to curtail classical studies have no reference whatever to the "ecclesiastical" character of the Latin tongue. That language has long ceased to be a medium of intercourse between scientists, multitudes of whom cannot write it or even speak it with ease. We have no doubt that a memoir written in English would be more widely intelligible than if drawn up in Latin.]

M. Hureau de Villeneuve maintains that distilled water is neither disagreeable to the taste nor hard to digest, and that the absence of calcareous salts is rather an advantage than an inconvenience.

Prof. C. S. Minot (American Association) opposes the suggested trimonial system. He thinks that species should be based upon a statistical study of all known variations. [The existence of any unknown species vitiating, of course, the result.] He holds that individuals are not always homologous, the only fixed units being (1) cells and (2) the whole series of generations of cells from a single ovum,—the cell-cycle. An individual may be almost any fractional part of a cell-cycle. Roughly speaking, the higher the organism the fewer the number of individuals it comprises.

M. Duponchel ("Comptes Rendus") considers that the secular variations of the compass are explained by the preponderating action of a new ultra-Neptunian planet, Oceanus, the revolution of which is about 467 years. In 1580 and 1813 it must have passed through the longitudes 80° and 260°, and is at present in the constellation of Capricorn, about 314°.

Mr. A. C. Ranyard communicates to the Royal Astronomical Society a description of a dark-blue grey belt upon Saturn, which he observed on November 4th, 1883, and which has since been seen by other astronomers.

Mr. J. Fiske, in a work on the "Destiny of Man," contends that "the more thoroughly we comprehend that process of evolution by which things have come to be what they are, the more likely we are to feel that to deny the everlasting persistence of the spiritual element in man is to rob the whole process of its meaning." But why in man rather than in other organisms?

M. Gaudry (Academy of Sciences) describes the fossil *Euchirosaurus* of the Permian of Lebach in Rhenish Prussia. This reptile, besides its highly-specialised ribs, had a ventral cuirass, flexible, and made up of strong ganoid scales; its vertebræ had spinous apophyses with great lateral projections, such as are not yet known in any other animal. Hence it was able to creep rapidly on its armour-coated belly.

According to M. Mary ("Comptes Rendus,") the length of the human step increases little up to a speed of 65 steps per minute. From that point it increases decidedly up to 75 steps per minute and then decreases. The most rapid walk is at 85 steps per minute.

Professor J. S. Newberry (British Association) maintains that the phenomena of the Ice-age, when the climate and physical conditions of Greenland reached as far south as New York and Cincinnati, make it impossible to accept Lyell's hypothesis of topographical changes as the cause. The elevation of the continent was at that time less than at present.

It will be remembered that Prince Bismarck some time ago gave his medical adviser, Dr. Schweinger, the title of professor (in partibus, we presume), though not occupying any chair. The Chancellor has since, in the teeth of the medical faculty, inducted his protegé into the professorship of Dermatology in the University of Berlin. The newly-appointed official has had the audacity to challenge Professor Dubois-Raymond for refusing to recognise him. If the prince can force such a man upon the University *Academische Freiheit* is at an end.

Prof. Sir J. W. Dawson ("Geol. Mag.") maintains that the Nile, like most other great rivers, has been only in part the excavator of its own bed.

According to a writer in "Science" the lantern of the lighthouse at Cape San Antonio was made to appear of a decided red colour by a cloud of insects which surrounded it during the night of August 23, 1884. The offenders were brilliant red Hemiptera, *Dysdercus sanguinarius*.

J. Starkie Gordon ("Geol. Mag.") considers that the Eocenes of England are the muds of an æstuary which flowed opening eastwards, while an enormous river flowed from the west. England seems at that date to have been part of a continent stretching across the Atlantic.

W. F. Stanley, F.G.S. (British Association), rejects the well-known theory of Dr. Croll on the cause of former ice-periods, and quotes observations proving that the mean temperature of the Southern Hemisphere, 15·4° C., is slightly higher than that of the Northern, 15·3° C.

"Science" considers the common misuse of the term "scientific" as an incurable evil.

According to the "Cape Times" a gigantic earth-worm, from South Africa, has been sent to Mr. F. Biddard (Beddard ?), Prosector of the Zoological Society. Its length is 6 feet 5 inches, and its upper surface is of a bright green. The name of the species is *Lumbricus microchæta*.

Dr. Jorissen (Royal Academy of Belgium) finds that hydrocyanic acid, or some substance from which it is derived, is widely diffused in the vegetable world, and probably fulfils important functions.

Mr. W. H. Preece, speaking at the Philadelphia Electrical Conference, said that there had been more lying, more swindling, and more rascality done over the question of storage batteries than over any other department of electrical science.

Mr. St. George Stock, writing in "Light," says that in the Southern Hemisphere the climate is growing perceptibly colder. "In the Banda Oriental, and in the Argentine Republic, houses used regularly to be constructed without fireplaces; now they are as regularly constructed with them."

Dr. Hammond, in a discourse delivered at Lehigh University, remarks that "Most civilised communities have enacted laws against the employment of children in severe physical labour. This is well enough. But no such fostering care does the State take of the brain of the young. There are no laws to prevent the undeveloped nervous system being overtasked and brought to disease, or even absolute destruction."

M. G. Colin ("Comptes Rendus") concludes, from a series of experiments, that—

1. Virulent agents, when introduced into animals upon which they have no injurious action, may preserve their properties untouched for one or two weeks.
2. These agents, after thus sojourning in animals where they remain sterile, may, if returned to others susceptible, produce their ordinary effects with an undiminished rapidity and intensity.
3. In certain cases these agents may produce, in so-called "refractory" animals, organic or functional diseases, severe and even fatal, though not analogous with those produced in susceptible animals.
4. Refractory animals, after having played the part of inert receptacles of virulent matter, may become the passive agents of contagion, though remaining themselves untouched.
5. The same animals may serve repeatedly for the transit of virulent matter without a former local deposit having the attenuating effects of a vaccination.

Dr. A. Mehring, at the last meeting of the German Congress of Naturalists and Physicians, read a paper on the heads of certain dogs found as mummies at Ancon, on the Peruvian coast. These "Inca dogs" represent three races—one resembling the sheep-dog, one a terrier, and another a bull-dog. Nehring considers the first-mentioned as the primitive form, while the other two have been developed. All seem originally derived from the wolf of North America, as a number of anatomic features testify. Wolves born and brought up in captivity undergo, even in the first generation, changes in the size and proportions of the skull, and in the size, form, and position of the teeth, which, when compared with the skulls and teeth of wild wolves, indicate a transition to the type of the domestic dog.

We regret to put on record the death of the eminent naturalist Dr. Alfred Brehm, on November 11th last.

3 JAN 1885

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THE AGNOSTIC:

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NATURAL HISTORY

THE
JOURNAL OF SCIENCE.

FEBRUARY, 1885.

I. THE LESSONS OF THE "MIGNONETTE" CASE.

MODERN researches on brain-diseases—whether temporary or persistent, functional or organic—have led to results which the moralist and the legist, however reluctantly, will find themselves bound to consider. "Reluctantly," we say, because such consideration cannot fail to invalidate some of the dogmas of the former and to scatter the precedents of the latter.

Setting aside certain palæozoïc writers who still view insanity not as disease, but as sin, and in itself worthy of penalties, we find amongst all who examine the subject a full consent. All agree that the man "out of his mind" cannot be treated as either morally or legally responsible for his actions. If such a man commits any crime he cannot, it is admitted, be condemned and punished like a sane man, though the public safety demands that he shall be placed where he can injure neither himself nor anyone else.

This principle, universally admitted in civilised countries, is carried into practice in various ways. In England the trial of the accused begins in the ordinary fashion, but his counsel raises the plea of insanity. If this plea is established by the evidence of the medical experts called, the judge directs a verdict of "Not guilty" to be entered, and the prisoner is sentenced to be placed in confinement during Her Majesty's pleasure. Sometimes it may happen that sentence—say of death—is passed in the ordinary form, but an application for commutation of sentence is made afterwards on the ground of alleged insanity.

Perhaps it would be preferable if, in all cases where the mental soundness of an accused person admits of doubt, a distinct and preliminary investigation of this point were first made, putting him formally on his trial only if adjudged rational.

But whilst so far all men are agreed there is a wonderful divergence of opinion when we ask who are to be adjudged irresponsible as insane? Are we to confine this exemption to persons who are uniformly and persistently deranged for some considerable time, or who are manifestly irrational upon all subjects? Or are we, as some propose, to extend it to persons who have, as it is asserted, a short and sudden fit of madness, during which they act in a manner quite contrary to their normal character, and of which they remember nothing when—perhaps after the lapse of a few hours—they recover their full consciousness? Here, surely, we are on very dangerous ground, where to lay down any hard-and-fast line becomes impracticable. Among these difficult cases ranks that of the drunkard. The law of England, as repeatedly declared from the Bench, declares that intoxication is no excuse for any crime, since the offender—if for the time being "demented"—is so by his own act and deed. Nevertheless drunkenness is constantly pleaded in defence or in extenuation, not merely by prisoners but by their advocates, and rarely, very rarely indeed, does any severe rebuke fall to the lot of either.

In America, however, it has been formally proposed that a criminal should be regarded as irresponsible, and consequently not to be punished, if it appear that he was drunk at the time when the offence was committed. Some writers have even gone further, and have contended that the state of degeneration, intellectual and moral, to which a man may be brought by the free use of alcohol, and indeed of a variety of narcotics, should likewise be received as a valid plea on behalf of persons accused of murder, incendiarism, forgery, &c.

No one will, of course, deny that a drunkard is for the time being insane; nor can we refuse to admit that the habitual alcoholist, even when not actually drunk, may lose to a great extent, and at times, the power of distinguishing between right and wrong, between lawful and unlawful. Still, without self-anticipation, we may remark that considerations of public safety prohibit the admission of these pleas.

But there is one agency which may derange the mind, intellectually and morally, in degrees varying progressively from a mere evil temper up to raving madness, and which must and will, in its more advanced stages, be regarded as rendering persons brought under its influence for the time being irresponsible. This agency is hunger, in anything beyond the degree in which it ensures a healthy appetite. To this agency public attention has been lately drawn by the case of the *Mignonette*,—lamentable in itself, and surely not less lamentable as to the way in which it has been treated by the highest judicial authorities in this self-styled enlightened age and country.

If we consider the effects of hunger we shall find that, even in a very moderate degree, it renders men eminently morose and cantankerous. Everyone can testify as to the impolicy of asking any man for a favour, or even for an act of simple justice, shortly before lunch or dinner, as the case may be.

But instead of a man in normal health, who knows that a meal awaits him at the usual time, let us take that of a man who even voluntarily abstains from food for an entire day, or takes for a longer time nourishment in merely homœopathic doses. As instances may serve the Russian peasant during his strict Lent, and the Turk during his Ramadan. It is difficult to imagine the degree of "envy, hatred, malice, and all uncharitableness" which at this time prevails. Suffice it to say that assassinations and malicious injury to persons and property are far more common, to an extent statistically recognised, than in any other portion of the year of equal length. It may not be considered a digression if we point to the absurdity of recognising fasts as a means of moral and religious discipline, when their demoralising effects are so clearly manifest.

We may go a step further: of all mortals the most malignant to their fellows are the ascetics, of all creeds, with whom fasts are interrupted only by insufficient food. With these men we find not merely the moral sense perverted, but the intellect is manifestly deranged. They see strange visions; they hear strange voices, and receive supernatural injunctions to deeds of cruelty.

We may perhaps here be permitted to refer to an experience of our youth. Making a pedestrian tour along with two friends, in a beautiful but very thinly-peopled country, we crossed a mountain ridge at a wrong point, and entered a region perfectly desert, where for at least thirty-six hours no food was procurable. We were so hungry that we could have eaten even an Anti-Vivisectionist had he fallen in our way. But the most prominent point was the alteration which came over our dispositions. The one theme of conversation was vicious recrimination, and the attempt to saddle each other with the blame of losing our way. As the second day wore on we all began to see, or fancy we saw, non-existent objects, which vanished or took other changes as we drew nearer. Thus there was full proof that we were experiencing a temporary derangement, both intellectual and moral. Yet we had advantages which the crew of the *Mignonette* had not. Every few hundred yards brought us to a spring of the purest water. More than all, we were in no fear of perishing. We knew that by following the valley into which we had strayed we must shortly reach an inhabited region. This was not the case with the survivors of the *Mignonette*'s crew: they did not know whether they should meet with help in time; and this very uncertainty is the most distressing, in fact the maddening, element of the case. Privations endured voluntarily, and which must shortly come to an end, may be borne far more easily than those where a fatal issue is the more probable. The fasting Russian or Turk, the ascetic monk, hermit, or fakir, has each the same sustaining reflection. He knows that food is procurable if he finds it impossible to prolong his abstinence any further.

We have further evidence of positive madness setting in, in its most frightful forms, after long-continued inanition. Relief has in recorded cases come too late.

Seeing thus the psychical effects of starvation, we may well ask with what faintest show of reason men in such a state can be held legally responsible for their actions? They are at the time being simply mad, their nervous systems having entered upon a process which must be viewed as decomposition. It is idle to talk about "temptation" which was no "excuse." A sane man may resist "temptation," but it is not within the power of the maniac.

It is perfectly possible that Lord Chief Justice Coleridge may not be aware of the *modus operandi* of starvation. It is likewise possible that had the truth been laid before him he might have refused to recognise it as coming from his enemies, the physiologists. But we might have expected that Mr. Justice Grove—himself a man of Science—would not have concurred in the judgment, and would at least have saved the intellectual honour of the Court from question.

We have now to look at the *à fortiori* argument in virtue of which these unfortunate men should have been pitied rather than blamed. The madman is not, in our times, put to death even for murder. A like exemption, as mentioned above, is proposed in America for the inebriate and for the chronic alcoholist. The former is, indeed, with us liable to safe-keeping for life. But wherefore? Because in a paroxysm of madness, which might occur at any moment, he might repeat the offence. We refuse to accept drunkenness as an excuse for the criminal, since every ruffian might plead drunkenness, or indeed, as often happens, might prime himself for the outrage with a dose of some intoxicant; but in the case of these unhappy cannibals on compulsion there is no fear of the deed of horror being repeated. The chances are doubtless millions to one against their being ever again placed in the same position. As utterly inconceivable is it that anyone would ever by semi-starvation qualify himself for committing murder with impunity. Whilst therefore these men were at the time being insane, and as such had a claim to be held free from responsibility, that insanity is not of a permanent or a recurrent type.

It becomes, therefore, difficult to conceive any sound reason for their punishment. To eliminate a public danger? Certainly not: under any normal circumstances these poor sailors, for anything that appears to the contrary, are no more likely to indulge in murder and cannibalism than Lord Coleridge himself. For their reformation? This end could not of course be effected by the death sentence nominally passed upon them, were it not absurd to speak of the further "reformation" of a madman when restored to his senses. For a warning to others? If unhappily the same circumstances should recur, other men placed in such a predicament, and driven to madness, if not deterred by the instinctive loathing of civilised man for the flesh of his fellows, would scarcely be influenced by Lord Coleridge's utterances and the final issue of the case.

On this view, that the Court was dealing with an act committed by madmen, all the authorities quoted and all the solemn comments made are flatly irrelevant. During the terrible Siege of Samaria, when women sacrificed their "weak and unoffending" children to prolong their own lives, the king rent his robes in horror; but he did not utter platitudes.

II. OBSERVATIONS ON FIBROUS PRODUCTS IN INDIA AND OTHER PARTS,

AND CONCERNING THEIR

ECONOMIC TREATMENT AND CULTIVATION.

By G. O'Brien.

THE natives of every country, from time immemorial, have been accustomed to utilise their fibrous plants; but want of roads, and the expense of transport from one country to another, restricted for the time their use to the respective localities where they grew: these hindrances no longer exist, and we are gradually becoming acquainted with their qualities and value, as also of the various methods employed in their preparation, and must acknowledge that the natives of Asia were the original discoverers of the inventions we still use, and with water as chief solvent. But each has much to learn from the other, and although the advance has been slow, inventors should be careful in putting forth their respective plans, and first ascertain whether they are original, as many of the latest methods patented have practically been in vogue for thousands of years in China and India, having only one fixed purpose—the cleansing of the fibre from resinous and calcareous matter.

I will therefore give the results of laboratory experiments, in order to analyse the subject in a practical manner, which exhibit that vegetable fibre is the most abundant and general ingredient of plants, existing in all their parts,—the root, leaves, stem, flowers, and fruit, amounting in compact wood to 98 per cent. It is obtained in a pure state by treating sawdust successively with hot alcohol, water, dilute muriatic acid, and weak potash lye, which dissolve first the resinous substances that bind the fibres together; secondly, the extractive and saline matters; thirdly, the carbonate and phosphate of lime; and lastly, any residuary matter.

In Europe our most familiar fibre is flax, and attempts at various periods have been made to supersede the ancient methods of steeping, and retting, using weak acids, solutions of caustic potash, and of soda, soap lye, and lime; but all have been found objectionable, as without excess of water the fibres become discoloured or loaded with impurities, and chemical additions are expensive. The most important impulse given to the flax industry in Ireland was by the unfortunate Earl of Strafford, temp. Charles I., who procured from Holland workmen and seeds, and is remembered in Ireland as a benefactor and chief promoter of the industry. The finest cambrics are prepared by the ancient system of soaking for lengthened periods, and the same method still prevails in most parts of Europe, using a cage 12 feet long by 8 feet wide and 3 feet deep, filled with flax-stalk weighted with stones, and anchored mid-stream from the month of May until September. Therefore, from following in detail these experiences, we must infer that pure water is the best and cheapest solvent, as it gradually, but perfectly, cleanses the fibre from the resinous substances which bind it together, and in the most economical manner, leaving only the phosphatic and earthy residuum to be disposed of, by using afterwards alkaline lye or caustic soda, and which are required to bleach it for certain uses.

The decay of plantations in many parts of India, and the fall in value of various productions, has drawn the attention of cultivators to fibre plants, which are too numerous to attempt to mention; but an imported one, producing China grass, from its value in commerce has merited attention. It is obtained from the stalk of the *Bœhmeria* (*Urtica*) *nivea*, a plant belonging to the Urticaceæ or nettle order. And in sequence various patents have been obtained, professing effectual and economical treatment; but all of them must be received with caution when we consider our own experiences, and that India and China are much older nations than ourselves, and that we have not yet been able to supersede the very methods inherited from them. Thus, for example of an impossible one, in the year 1849 Messrs. Wright and Co. obtained a patent for the preparation of this fibre; their process consisting essentially in boiling the stems in an alkaline solution after they had been previously steeped for twenty-four hours in cold water, and also for twenty-four hours in water at 90° F.; the fibre is then washed thoroughly with pure water, and finally subjected to the action of high-pressure steam. Another German patent has made a new and useful departure, using bisulphide of lime under pressure of steam on pine fibre (shavings or sawdust), procuring wood-wool for surgical purposes, as also for clothing, but for which it cannot be considered as a competitor to like substances, animal or vegetable. All Orientals are acquainted with several species of the Sapan tree, which produces pods serving as a substitute for soap, but not in sufficient quantities for manufacturing uses, and in efficacy could not compete with caustic soda, which can be imported into India from Europe at £8 per ton, and is the most likely substance to be useful after the resinous substances have been disposed of. And trials could be made, using for the purpose a wooden boiler, say 6 feet long and 14 inches wide by 14 inches deep, and bolted together by ½-inch screw-bolts inside the box, which should rest on walls of mud 3 feet high, with that clear space for a wood fire beneath; the sides of the boiler to be built in by a mud wall about 8 inches thick, to conserve the heat to boiling-point if required; and a small chimney is necessary to carry off the smoke and conduct the flame along the bottom of the boiler, which would last a long time if kept with water and clear from cemented sediment; and I have used such primitive boilers for other purposes, from knowing that they were used in our first steam-boilers in consequence of the urgent necessities of inventors, and only by such trials on the spot can advances really be obtained, following out in the main Chinese methods, which do not injure the fibre.

Dr. John Forbes Royle says of the *Bœhmeria nivea*, or Rhea fibre-plant, that it is likely to prove one of the most valuable products of India, for in strength it exceeds the best hemp, and in fineness it rivals the superior kinds of flax. Its culture is well known to the natives of Assam, and it has also succeeded in Tenasserim, and it is grown in Siam and other eastern countries and islands, and can now be produced, and sold with profit, at as cheap a rate as Russian hemp; and if any machine could be employed for facilitating the separation of the fibre from the outer bark and the woody parts of the stalk, it would speedily undersell all other fibres, as from four to five crops per year can be obtained from the same plants; it is identical with the Rhea grown in China, but of coarser quality. In its cultivation manure is required, and moisture essential to quick growth, as well as shade, and some protection from storms. It is grown from separate roots, and may be cut down several times in the year, and the aggregate produce of an acre is about 12 maunds.

"The different crops vary in quality, the earlier being the strongest and finest, and the veritable China grass sells in this country at from £60 to £80 per ton. Very serious faults have been committed in the process of cleansing Indian fibres, which have tended in a great measure to deprive them of their value for manufacturing purposes. In order to save labour the usual practice has been to steep the plants till the sap and vegetable juices are thoroughly decomposed, as the fibre can then in most instances be easily beaten or washed out; but this method, though applicable to a certain extent in cold climates, where decomposition takes place slowly, is always found to be injurious to the fibre, and to be almost inapplicable in warm climates, where fermentation passes into putrefaction in a few days, and the decomposed fibre acquires acidulated and other properties, which not only deprives the fibres of their strength, but discolours them in such a manner as to render them unfit for manufacturing purposes. Most vegetable substances contain, besides the fibrous tissue, sap, cellular tissue, and a little colouring-matter. The sap consists of water, gum, fecula, and alkali, with sometimes tannin."

In the above explanation running water is not prescribed, which is necessary with high-priced fibres for cambrics, &c., in Europe, as well as in India.

From the "Cyclopædia of India," by Edward Balfour, I copied the following for those who have not read it:—

"The leaves, stalks, or barks of plants should be cut when in full vigour and of bright green colour, as when old or dry they yield coarse, stiff fibre, and no more plants should be cut than can be cleaned in two days, and the cut plants should not be left long exposed to the sun, as the sap dries up, and the process of cleansing them becomes more difficult. The sooner the sap, pulp, and impurities can be removed from the fibre the cleaner and stronger it will be. Beating, crushing, and scraping fibres improve their quality instead of injuring them, as was at one time supposed, provided it be not cut across or rendered short. If a plant be well crushed or beaten soon after it is cut it may be immersed for a night. Each district in India has its own particular fibres, all largely utilised by the people; thus it will be superfluous to detail them, but the beautiful fabric China grass cloth is made in Canton province, and the plant supposed to produce it is the *Urtica nivea*, and can be spun into thread for sewing purposes, and the cultivated variety has larger leaves than the wild plant, which grows plentifully on sloping banks, but is not prized by the natives, who say that its fibre is coarse and broken, and confined in its structure."

And Dr. Roxburgh describes it as the *Urtica tenacissima*, or China grass, and states that this nettle grows in all the moist countries, from Bengal, through Rungpore, Assam, and China, and adds:—

"*To Cut the Rhea.*—It is fit for cutting when the stems become brown for about 6 inches from the root, holding the top stalk in the left hand, and with the right hand strip off the leaves, by passing it quickly down to the roots, and cut off with a sharp knife, taking care not to injure the hairy work of the roots, as these should be covered up quickly to ensure rapid growth. Then lop off the tender stalks, and make up into bundles of 200 to 250.

"*To Strip off the Bark and Fibre.*—The operator holds the stalk in both hands nearly in the middle, and pressing the forefinger and thumb of both hands firmly, gives it a peculiar twist, by which the inner pith is broken through, and then, passing the fingers of the right and left hand alternately towards each end, the bark and fibre are completely separated in strands.

"*Making up of the Bundles.*—The strands of bark are now made up into bundles of convenient size, tied at the smaller end with a shred of fibre, and put into clean water for a few hours, which he thinks deprives the plant of its tannin or colouring-matter, the water becoming quite red in a short time.

"*Cleansing Process.*—The bundles are put on a hook fastened in a post by means of the tie at the smaller end, at a convenient height for the operator, who takes each strand separately of the larger end in the left hand, passes the thumb of his right hand quickly along the inner side, by which operation the outer bark is completely separated from the fibre, and the riband of the fibre is then thoroughly cleansed by two or three scrapings of the knife.

"This completes the operation with a loss of about one-fifth [should be about 95 per cent]. It is then dried, and is fit for exportation, but the appearance of the fibre is improved by a night's dew or a shower of rain."

The requisition to cut open and strip as much as possible China grass, in order to expose it to the action of water for the purpose of dissolving the gummy compounds which bind the fibres together, and this before they have become dried by sun and air, is absolutely necessary, otherwise—if these and also colouring-matters are not completely removed before drying—the fibrous parts become stiff, coloured, entangled, and useless. But when properly prepared the most beautiful fabrics can be manufactured with its fibre, and it is much coveted by our cloth manufacturers to strengthen the framework of the finest cloths as well as coarsest "shoddy," but the price demanded by the Chinese does not permit its general use. And it is noticeable that in limited quantities it realises £80 per ton in England, but when the price lowers to £35 per ton then the Chinese entirely cease to export it; but for cloth we cannot afford to pay more than £25 per ton, and thus this beautiful fibre is prohibited to us from its price. The Government of India has offered a high reward for the best machine to prepare it, but inventors have misdirected their powers by using in the first instance chemical substances, or on machinery to be used after it is prepared, whereas the whole secret lies in treating the plant while still green and within six hours after it has been cut, and whilst adhesive compounds remain soluble; and it is clear that excessive handling must be avoided, as Chinese labour is the cheapest in the world combined with intelligence. And thus, as the substances to be got rid of are merely gum and tannin matter, and both as they exist in China grass are soluble in water, I find that by soaking the grass, when freshly cut, for eight hours in pure water (running stream is preferable), by placing the "grass" in a wooden box or crate with bars or spokes on all sides, and with a movable lid or cover made to rise and fall by means of a lever or lift, and thus wash out by pressure and motion the soluble substances, giving equal effect and pressure on all the plants whilst in the water; and the bottom of the crate can be made to rise and fall also, modifying it in shape and action to procure the effect needed. This method does not hurt the fibre in general if the bars be so adjusted as not to press on each other, and would effect the object desired at lowest possible cost, and I have sufficiently tested the plan myself to ascertain its effects. When the whole of the gum is got rid of, then the rest of the operation is easy, by drying the treated plant at once in the sun, and then separating by scutching machinery, producing in fibre only about 5 per cent of its original weight, the shortest fibre being serviceable for rough cloths, and the longer for superior requirements.

The above ideas are applicable to most fibre plants, and exhibit the necessity of treating them as fresh and green as possible.

130, Fenchurch Streeet, London, E.C.,
December 16, 1884.

III. IS DEATH UNIVERSAL?

A COUPLE of years ago we pointed out ("Journal of Science," 1882, p. 401) the curious fact that—as established by the researches of Bütschli, Weismann, and Goette—the monocellular Protozoa are not, like all higher animals, subject to death. From this fact we drew certain conclusions. The subject has since been further examined by Dr. K. Möbius ("Biolog. Central-Blatt, vol. iv., p. 389). The conclusions of this eminent *savant* may serve at first sight to differ from the views which we put forward; but on closer examination it will, we submit, appear that the difference is more verbal than real. Admitting the same facts, we apply to them merely somewhat different names.

In monocellular animals which propagate by division the entire bodily substance of the older individuals—as Bütschli and Weismann have proved—continues to live in the young individuals into which the former have resolved themselves by the act of fission. In the polycellular animals—the Metazoa—a part of the body, after passing through the various stages of its development, loses the power of carrying on vital processes, and dies. Hence Weismann ascribes to the Protozoa immortality. He argues that, as they are resolved by fission into a number of individuals of which no one is older and no one younger, we have an endless series of individuals, each of which is as old as the species itself, and each of which has the faculty of living on indefinitely by constantly renewed fissions. The higher organisms, on the other hand (the Metazoa), have lost this faculty of endless life. In them the immortality of the monocellular organisms is restricted to the reproduction-cells alone.

The reply of Möbius is substantially that, according to the definition hitherto generally accepted, we understand by the "immortality" of an individual living being the innate attribute, not destructible by external causes, of continuing for ever as an individual.

We must here convict Dr. Möbius of an inaccuracy of some importance. Weismann nowhere—as in common with ourselves—asserts the immunity of the Protozoa from outward causes of death. We said expressly that with the Protozoa death, "though common enough, is merely casual, the result of some accident. Hence immortality is ascribed to them in a sense which is not dependent on the ordinary definition of the term."

Möbius now asks—Is this idea of immortality applicable to the Protozoa which propagate by fission? Do they persist as individuals until their life is destroyed by some outward agency?

He replies that adult Protozoa, in their fissiparous generation, leave no part of their body behind which can die. But they cannot on that account be regarded as immortal, for, on fission, their individual existence is gradually extinguished, and comes to an end in the moment when the daughter-offsets separate from each other. With the conclusion of the process of fission the mother-individual ceases to live, but the substance of its body carries on the same specific functions in the effects, and indeed with a rejuvenated susceptibility to external impression, which in the aged individuals had been gradually fainter and fainter, and had finally ceased altogether.

To this it may be replied that there are only two alternatives—death or deathlessness. If death occurs let the dead body—the mass of organised matter which has ceased to perform any vital function—be produced. Failing this evidence we must recognise deathlessness. When a monocellular Protozoan is killed by heat or poison, we have this dead body to produce. Consequently where it is not producible we fail to recognise true death.

Dr. Möbius continues—Whilst the bodily substance reacts more faintly to outward impressions, there appear in its interior striking movements which precede the fission of the maternal body, and evidently subserve the rejuvenescence of such substance for its progeny.

The retraction of the cilia, the disappearance of the flagella, the rounding off of the body, and its incapsulation before fission must enfeeble the irritability of the older individuals. The young offshoots begin their individual life with great susceptibility to external impressions, because their bodily substance consists of freshly-located molecules, and because the surface of their body is greater in proporto its mass than the superficies of the mother shortly before fission.

When an Infusorium completely uses up its entire body in the production of two, four, or eight young ones, every part of such body remains alive,—*i.e.*, the atomic groups, of which every offshoot consists, continue their life-work according to the same morphological, physiological, and psychological laws as the mother, although each for its own individuality. The young individuals ingest nutriment, and transform it into their own bodily substance. Thereby they not merely replace the losses indispensable to vital work, but they accumulate also an excess of bodily substance in virtue of which they grow. When they have become as large as their mother, and are resolved into two offshoots, each of these inherits at most one-fourth of the vital mass of its grandmother. In the third fission each offshoot receives at most one-eighth, in the fourth one-sixteenth, and in the tenth at most 1-1024th of the ancestral body with which we started. We have here not taken into account the losses from decomposition which the ancestral substance must have undergone in all generations, since in the Protozoa one and the same bodily mass which is concerned in reproductions fulfils all other bodily functions. The Protozoa, consisting of one plastide only, possess no working plastides along with the reproductive plastides of the Metazoa. Subsequent generations of Protozoa consist, therefore, more and more of bodily substance which they have individually elaborated, and less and less of ancestral constituents.

The individualisation of the daughter offshoots begins with the first stages of fission in the mother. These stages are the unfelt and unconscious state of the separation and transformation or re-formation of organs before these are capable of receiving and utilising external impressions. This unconscious state gradually passes into the condition of sensibility and consciousness as soon as external impressions are received by special organs. Special sensations must be induced, even in the Protozoa, by contact with foreign bodies, by changes of temperature, by the ingestion of food, by changes of the form and the locality of the body, by the recognition of fellow-individuals, &c.

The Protozoa are, like the Metazoa, to be regarded as psychically centralised individuals. In the severed psychic centres of the offshoots the former psychic centre of the mother cannot persist, because her individual bodily and spiritual life is extinguished in fission. The Protozoa can therefore, from a psychological point of view, not be regarded as immortal.

It may here be contended that the author is assuming too much. There is every reason to suppose that the offshoots must inherit impressions made upon the mother, since each of them must inherit a part of her psychic centre.

In the stalked Protozoa, also, such as *Zoothamnium*, *Epistylis*, *Codoriga*, the individual soul-life of the mother does not persist in her united descendants, since these, in addition to their common functions and feelings, receive individual stimuli and perform separate individual functions. The offshoots receive from their mother, on fission, merely the foundation for their individual bodily and psychic life. This simple basis of the new individual life is formed in the Metazoa by gemmules, or by germ-cells and spermatozoa.

The reproductive cells of the polycellular animals, or heteroplastides (Goette), transfer their vitality, like the bodies of the monoplastides, from individual to individual without an intermediate stage of lifelessness and death. They form, however, voluminous masses of other plastides for more powerful and varied life-work than can be executed by the tiny bodies of the monoplastides. These developed working plastides, incapable of reproduction, can, for the most part, still continue to work in their manner when the reproductive plastides have been separated from the body of the polycellular animal. Most heteroplastidic animals survive, therefore, their act of reproduction, whilst the individual existence of the monoplastides must come to an end with the act of propagation, since in them the working and the reproductive substance are identical.

Morphologically considered the body of the monoplastides corresponds to the reproductive cells of the heteroplastides. The life of both, however, is very different. Whilst the reproductive cells of the polycellular animals live on in a state of inaction till they are liberated, transmigrate, and develope themselves, the monocular animals enter into relations with the external world, even with the bodily mass concerned in reproduction, and may evolve for this purpose especial organs. The reproductive plastides contain groups of atoms for the formation of all the organs of the body of their species. The plastides of individual organs which have merely certain limited functions contain such atomic groups only which are suitable for the formation of young plastides having the same especial properties (protective, motive, nutritive, and sentient plastides).

The reproductive plastides of the Metazoa receive no direct stimuli from without, so long as they have not become liberated. Hence they are not worn out. They do not age by work like the working-cells; but as soon as certain external stimuli act upon them after liberation and fecundation, they act in accordance with their inherent properties with fresh and full energy. When the reproductive plastides of the Metazoa do not in a certain time become free individuals, whose capacity for development is called into activity by certain external stimuli, they die off just as do the working plastides.

Upon all the latter external stimuli react more feebly when often repeated. They become weary, and their weariness terminates finally in non-irritability and in death.

The psychic centre or soul exerts a conservative action upon the body, which becomes fainter as the individual ages, because stimuli evoke feebler and feebler feelings of satisfaction, and elicit therefore fainter reactions.

It will be seen that, whilst Dr. Möbius has in many respects enriched our knowledge of the subject, he has not succeeded in showing in the Protozoa any phenomenon fairly comparable with death in the Metazoa.

IV. DEATH AND INDIVIDUALITY.

By C. S. Minot.

[We insert the subjoined memoir, taken from our American contemporary "Science," as throwing new light on a subject previously raised in our pages.]

THE current conceptions of death as a biological phenomenon are very confused and unscientific. In this essay I shall endeavour to analyse the problem, and, by placing the factors concerned in a clearer light, to diminish the obscurity in which the subject is still involved. This appears to me the more desirable because the recent publications of Weismann and Goette upon this general topic have increased rather than lessened the existing confusion. In fact these authors fail to make the necessary distinctions between the different kinds of death, the different orders of individuality, and the different forms of reproduction. This assertion is, I believe, justified by the following paragraphs :—

First, as regards individuality. Individuality, as it is generally understood (*i.e.*, as something always equivalent to itself), does not exist in Nature, except subjectively as a rather fantastic notion of the human mind. The term "individual" is applied to things utterly incommensurate with one another. An individual protozoon, an individual polyp, and an individual insect, are not homologous and comparable bodies. It is mere slavery to a false form of speech to imagine that their "individuality" is a common quality; for, on the contrary, the same word indicates here three distinct phases. I know not how to account for the immense significance attributed to the mystical idea of individuality, which in reality corresponds only to a physiological capacity for a separate existence, but in usage is tacitly assumed to be the name of some vague fundamental property of life, which, however, the mind cannot apprehend. Now, we have renounced considering a wing in a bee, a bird, or a bat as identical or homologous with every wing, either on account of its name or its function. But, although the different kinds of individuals of animals and plants are much more unlike one another than are the manifold types of wings, yet individuality is generally taken to mean a uniformly identical something; and that is untrue. Of course the matter is really very simple, and indeed self-evident, as to its true nature; and the singular obscurity prevailing is probably due only to the problem not having been clearly thought over. At present the condition of opinion upon the subject reminds one of the ancient notions of beauty, according to which beauty was an inherent quality of objects, not an impression of the mind, a psychological state. Despite custom, it is plain that "individual" has many meanings; yet it is usual to compare "individuals" with one another throughout the animal kingdom. This error has been repeated by Weismann and Goette, because they both assume that the death of a single protozoon is equivalent to the death of one of the higher animals. Goette, however, has partially emancipated himself from this idea, which I believe to be erroneous. The death of a unicellular is entirely different from the death of a multicellular individual.

To Huxley we owe the first scientific determination of individuality. His essay on the subject ought to be thoroughly studied by every biologist. Life occurs in cycles of cells; *each cycle comprises all the cells springing from a single impregnated ovum;* the whole of every cycle is homologous with every other whole cycle, no matter whether every cell is a so-called individual, or whether they constitute several individuals (*e.g.*, polyps) or a single one (vertebrates). *All* *cells are homologous, all cycles are homologous; but individuals are not always homologous*, since an individual may be either the whole or any fractional part of a cycle. This question I have discussed a little more fully in my article on "Growth as a Function of Cells" ("Proc. Boston. Soc. Nat. Hist.," xx., 190—201). Manifestly the death of the single cell is not necessarily identical with the termination of a cycle. Now, when a man, he being a cycle of cells, has lost the ability to continue the cycle, he (or it) dies. Further, it is inherent in his constitution to lose that ability gradually; hence, when it is completely lost from internal causes, he dies, as we say, from old age. It is to this ending-off of the cycle, from causes resident in itself, I wish to restrict the term "natural death."

We have now two questions to pose: 1. Do all organisms belong to cell-cycles? 2. If so, are all cycles self-limited? In common language the second question would be, Is death always the natural and inevitable accompaniment of life?—an inquiry which may appear singular, but is none the less perfectly sensible and legitimate. Weismann has answered it with a negative.

1. I maintain the hypothesis that all organisms do develope in cycles, and only in cycles; which involves the assumption that all living species begin their life-history with an impregnated ovum or its equivalent. We come, therefore, at once to the question of how far sexual reproduction extends downward in the scale of life. I deem it very probable that it extends to the lowest animated being, even though it be quite differently manifested in the lower forms from what we observe in ordinary bi-sexual reproduction. This view is opposed to the opinions generally held; for botanists trace the evolution of sex within the vegetable kingdom, and zoologists trace it, though less definitely, within the animal kingdom. We are thus forced to assume that sex, one of the most fundamental and characteristic phenomena of life, has arisen twice. This is to the last degree improbable. Such a coincidence would be the most extraordinary result of chance within human experience. It is more reasonable to suppose that, though we do not yet recognise it, the sexual function exists in the protobionts, which are neither animal nor vegetable, and that they also produce a body homologous with an impregnated ovum; and to suppose, further, that out of this common commencement both animal and vegetable sex have been evolved. The essential property of the sexually produced ovum is its power of repeated division, producing a succession of cell-generations, which, together with the original body (*ovum*), con-

stitute the cycle. There is much evidence of a positive character to confirm the belief of the cyclical course of life, even among the Protozoa and Protophytes, in which there occurs what is known as rejuvenation (*verjüngung*).

2. I maintain that it is probable that all cycles of cells are self-limited. Let us first ascertain the nature of the limitation. Our knowledge of the manner in which the cycles are limited (*i.e.*, of the causes of natural death) is very restricted, and derived solely from the higher animals. My own special investigations have been in this field, and have led me to the opinions and problems we are discussing.

My experiments demonstrate that, when properly analysed, the growth of at least the higher animals gradually diminishes from birth onwards, almost without interruption. This is an irrefutable mathematical verification of the views which I advanced in my article on "Growth as a Function of Cells," published in 1879, the essence of which, as far as we are now concerned, is that the cells of a cycle continuously lose their power of division, so that the interval between two successive divisions gradually increases. This involves the ultimate termination of the cycle, because the losses go on, not until the cells can no longer divide, but until they exhaust themselves. This whole series of changes is properly *senescence*, or growing old. Senescence is a continuous process, covering the whole period of a cycle of cells; and we must assume it is the positive loss of power in the single cells, such that the last-produced cells cannot continue, and *natural death* ensues. Of course, in the cases of a multicellular animal, death of the whole follows secondarily upon exhaustion of any essential part,—as in the case of insects, which die upon laying their eggs. In the higher animals, the cycle is limited by senescence, and senescence is a decay which probably begins when the cycle begins. The next point to decide is, whether the same phenomenon occurs with the unicellular organisms. If it is found that the divisions of a Paramecium, for instance, after a conjugation, are at first rapid, and then follow at increasing intervals, it would prove (provided always the external conditions remained constant) that we here had true senescence, with its sequel, natural death, or the end of the cycle. Until this point is settled we cannot know whether there is, among unicellular animals, a form of death homologous with the natural death from senescence in the higher animals and plants.

It is to be regretted that both Weismann and Goette appear not to know the article to which reference has just been made; otherwise they would have recognised that the problem of death is, *first*, whether growing old (*veraltung*, *involution*) is a universal phenomenon of life. Weismann's first article was an address delivered before the German Naturforscher versammlung, September, 1881, and subsequently republished at Jena. He advanced then the view that for unicellular organisms there is no death except through accident; that the propagation being by simple division, we must assume that the process of division may go on for ever. He does not even consider whether the cells form cycles, and whether these cycles need to be renewed; so that he misses the real problem. On the contrary, he is enchained a prisoner to the mystical idea of individuality, and reasons as if individuality rendered direct comparisons legitimate between things essentially different. All his reasoning is based upon the idea that an individual protozoon is comparable to an individual dog, and so on. The argument just made against him was to show that the basis of his whole fabric is illusory. Bütschli, in his short article, called forth by Weismann's, partially liberates himself from the confusion as to individuality, and propounds the hypothesis of a *lebensferment*, which he supposes to be continually resumed in Protozoa, which he thus assumes to be potentially immortal. He also fails to recognise that the true question is, not whether single Protozoa die, but whether they form senescent cycles. In this error he is followed by Cholodowsky, who also admits that natural death is restricted to the multicellular animals, but overlooks what would be its only possible homologue among Protozoa.

Goette seems to me to have made a distinct advance beyond his predecessors, for he has attempted to show that there is a death common to all organisms. Especially is his conclusion that death and reproduction are intimately connected to be noted as important; but his thought appears to me often vague and obscure, and to many of his views I can by no means assent. I have just asserted that death and reproduction are intimately connected. Now, if my theory is correct, it is evident that each cycle, before it is completely exhausted, must produce the initials of new cycles: hence the connection in time between maturity, or the approach of death, and sexual reproduction. By speculation upon the few available facts I have reached the following hypothesis:—Originally each cell of a cycle was a distinct individual; the exhaustion of the last cells of the cycle *caused* them to become sexual bodies and to conjugate; conjugation renews the power of division in the conjugated individuals, and therewith a new cycle is begun. Subsequently multicellular animals were evolved, and in these the same phenomena recur; but some of the cells have becom specially organised, and thereby incapable of assuming th sexual state: hence, when the end of the cycle approaches only a few cells become sexual, and the animal (or plant) is mature. The higher organisms become sexually active only after having grown for a considerable period, because they still preserve the primitive relation. Senility is the *auslösende reiz* of sexual reproduction. I hope to discuss the matter fully in a memoir which I am now preparing for the press.

It is evident that, according to this hypothesis, sexual reproduction depends on the exhaustion of the cells. There are many facts known to confirm this view. Thus among men the reproductive period begins sooner when they are ill fed. Among many of the lower plants reproduction is induced by defective nutrition. I believe that nutrition and reproduction are indeed opposed to one another, but by no means in the sense taken by Carpenter and Spencer. While I consider that the impaired nutrition causes the effort to reproduce, they believe that reproduction is opposed to nutrition, constituting a tax which withdraws just so much from the parent. Undoubtedly in those cases where the parent, in consequence of a secondary addition to the office of genesis, has to supply food to its young, reproduction may detract from growth, but, even in such cases, only sometimes. Carpenter and Spencer's whole argument rests upon the assumption that the power of assimilation is only just equal, or about equal, to the demands of the parent. It is, however, perfectly well known that the reverse is true, and that there is in most organisms a large surplus of assimilation possible, which is used whenever the functions demand it; hence in most cases the secondary taxes of reproduction can be wholly or mainly paid without calling on the growth capital of the parent. Spencer's *à priori* argumentation I consider superficial: it has led him to an exaggerated idea of an opposition which exists in Nature, but is not general. Moreover, Spencer has mistaken the cart for the horse: animals do not stop growing because they begin to reproduce, but they begin to reproduce because they stop growing; or, more strictly speaking, both events are due to one cause,—senescence.

It will be seen, upon reviewing the preceding paragraphs, that the views I advocate are opposed to all the other opinions upon the nature of death which have been noticed above. In a memoir I am now at work upon I hope to array a large number of observations to defend the theory outlined in this essay.

V. SPACE AND ITS DIMENSIONS.*

HAD either of the two works before us made its appearance half a century ago the author, if not straightway consigned to a lunatic asylum, would have been overwhelmed with derision. Little better would have been the lot of an unfortunate reviewer who should have ventured seriously to discuss such an audacious and unheard-of supposition. Times are, however, changed,—in this respect fortunately so—and we may at least take the possibility of *n*-dimensional space into quiet consideration.

One misunderstanding must be brushed aside at the outset : We hear it sometimes asserted that the conception of four-dimensional space, as at least possible, is, in some way or other, an outcome of Spiritualism. This is quite erroneous. The late Professor Zöllner did certainly maintain that some of the most perplexing phenomena manifested at spiritual séances could be explained by the hypothesis of space of four dimensions. But between the two there is no necessary connection. A believer in the genuine character of the so-called spiritual manifestations may reject and scoff at the poly-dimensional hypothesis. On the other hand, a person who accepts "poly-dimensionalism" may regard Spiritualism as fraud and delusion. For the rise and progress of this strange hypothesis the mathematicians are alone responsible. Strange, indeed, and suggestive that the most sober, rigid, and exact of the sciences should thus point the way to what the men of practical common sense will deem foolishness!

It will at once be granted that our senses and our ordinary experience tell us of three-dimensional space and nothing further. We take up any solid body whatever, and we find it has always, to our touch and sight, length, breadth, and thickness, the latter being often called depth or height. We stand in the open air and we recognise the same three dimensions—one, from east to west, another from north to south, and a third, from the ground on which we stand, upwards. We may, in thought, prolong any one of these lines indefinitely, or, on the other hand, suppose them reduced to microscopical magnitude we have still merely length, breadth, and depth. How then do we escape from an experience so universal that it affects even our powers of conception? How are we led even to raise the question, "Why should there be three and only three dimensions?"

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* Scientific Romances: No. 1. "What is the Fourth Dimension?" By C. H. HINTON, B.A. London: W. Swan Sonnenschein and Co.

Flatland: A Romance of Many Dimensions. By A SQUARE. London: Seeley and Co.

Certain very elementary mathematical considerations fully warrant us in making this inquiry, and even in seeing that space does not necessarily involve three dimensions, and neither more nor less.

We take for instance a line 2 inches or 2 centimetres long. If we multiply 2 by itself we have 2^2, or, as it is expressed in words, two in the square. This number, thus obtained by multiplying 2 by itself, we can symbolise as a square, each of whose sides is 2 inches long. We then again multiply 2 × 2 by itself and get 2^3, called 2 in the cube, or the cube of two. This result we again symbolise by a cube, a solid figure 2 inches long, 2 broad, and 2 thick or deep. Here, then, we have passed from the finite right line 2, to the plane figure 2^2, and again to the solid cube 2^3. But what if we go on and raise our original 2 to the fourth power or biquadrate, $2 \times 2 \times 2 \times 2$ or 2^4? This we can no longer symbolise by any figure we can see or touch, or even definitely conceive. We know that a finite line is bounded by 2 points, a plane square figure by 2 × 2 right lines, and a cube by 2 × 2 × 2 square planes. Therefore, passing on in the same serial order, a figure representing 2^4 must be bounded by $2 \times 2 \times 2 \times 2$ solids. Now, we cannot realise to ourselves such figure. It must not be merely a larger cube; it must differ from the cube just as essentially as the cube differs from the square, or as the square differs from the right line. We cannot obtain the cube by superimposing any number of plane squares upon each other, because the plane figure has merely two dimensions. If we wish to generate a square plane figure from a straight line we must suppose the line to be moved in a direction *not contained within itself*, since the only possibility of motion in a straight line is from one of its extremities towards the other. In like manner, if we wish to generate a cube from a plane square we must move the plane in a direction *not contained within itself*, that is not in length or breadth, from the left to the right, or the front to the back, but upwards or downwards. All this is perfectly clear and simple. But suppose we wish to generate the unknown biquadrate. We must then in like manner move the cube in some direction *not contained within itself.* And here lies the difficulty, for the direction wanted lies outside the pale of our experience. But does our inability to point out this direction inhere in the very nature of space, or is it merely due to the limitation of human faculties?

Here both our authors have recourse to a perfectly legitimate artifice. Both suppose a set of beings, who are merely two-dimensional, having length and breadth, but not thickness, and to whom space—in fact the universe—appears two-dimensional also. To these hypothetical beings the third dimension, depth or thickness, appears as inconceivable and impossible as the fourth dimensional is apt to do to us. Mr. Hinton examines formally external phenomena as they must present themselves to such beings. The anonymous author of "Flatland" represents himself as a dweller in two-dimensional space. He describes to us his world with all its strange peculiarities, interweaving with his story much satire of perhaps questionable relevance. Especially is it to be noted that research in certain directions is in "Flatland" discountenanced, not merely by social penalties, but—as in modern Britain—by positive law. Researches into the origin of light are strictly forbidden, and the author himself is ultimately doomed to perpetual imprisonment for having indiscreetly expressed a belief in the possibility of three dimensions.

Whether to a polydimensional intelligence our beings and doings will appear as absurd as those of the Flatlanders,—here described—do to us, is, from the present human point of view, an unapproachable question.

Previous to the supposed author's conversion to a recognition of three dimensions he has a remarkable dream, after an evening spent in geometrical studies. He sees in imagination a one-dimensional world, Line-land. Its inmates are aware of only one dimension in space, and can no more conceive of two dimensions than the Flatlanders can of three, or than we worthy Spacelanders,—as the author calls us—can of 4, 5, or *n* dimensions. He has a long discussion with the king of Line-land, and vainly tries to convince him of the limits of his own existence and of the possibility and reality of two-dimensional space with its necessary results. To the king of Line-land a voice or any other manifestation coming from any point save exactly before or behind him seemed to originate in his own inside. This vision made our Flatlander thoughtful. There dawned on his mind a vague, dim presentiment that there might exist worlds or regions of being of more than two dimension,—as inexplicable to him as a fourth dimension is to us.

A further incident now occurred to disturb his traditional notions of the nature of space. He has been giving his little grandson, a boy of "unusual brilliancy and perfect angularity," a lesson in arithmetic as applied to geometry. He is told that 3^2 represents the number of square inches in a square whose side is 3 inches long. The boy replies:—"You have been teaching me to raise numbers to the third power; I suppose 3^3 must mean something in geometry; what does it mean?" "Nothing at all, replied I, not at least in geometry, for geometry has only two dimensions." The author then proceeds to show his grandson how a point by moving through a length of three inches makes a line of three inches, which may be represented by 3; and how a line of three inches, moving parallel to itself through a length of three inches makes a square of three inches every way, which may be represented by 3^2. Thereupon the boy returned "Well, then, if a point by moving three inches makes a line of three inches represented by 3, and if a straight line of three inches moving parallel to itself makes a square of three inches every way, represented by 3^2, it must be that a square of three inches every way, moving somehow parallel to itself, must make a something else of three inches every way, and this must be represented by 3^3."

As a punishment for this heretical and paradoxical outbreak the boy is sent to bed. Shortly afterwards our hero becomes conscious of a presence in the room. Seeing, however, nothing, he soliloquises:—"The boy is a fool, I say; 3^3 can have no meaning in geometry." To his horror a voice replies:—"The boy is not a fool, and 3^3 has an obvious geometrical meaning."

Not to enter into details, our Flatlander finds that he has a visitor from the three-dimensional world, who endeavours, though vainly, to open his eyes to the comprehension of space and body as it appears to us. At last the stranger soars away with him into a new world where wonderful revelations await him. He is introduced to cubes, and he learns to distinguish between a circle and a sphere, a plane figure and a solid. But he now curiously turns the tables upon his guide. Having mastered the idea of three-dimensional existence he craves to go higher. He pleads:—"What, therefore, more easy than now to take thy servant into the blessed region of the fourth dimension, where I shall look down upon this land of three dimensions, and see the inside of every three-dimensioned house, the secrets of the solid earth, the treasures of the mines in Spaceland, and the intestines of every solid living creature, even of the living and adorable spheres." To his disappointment he is told "There is no such land; the very idea of it is utterly inconceivable."

But our Flatlander refuses to be so silenced. He quotes the words used by his guide when instructing him in the nature of solids. He exclaims, after summarising the generation of a line from a point and of a square from a line :—"In three-dimensions did not a moving square produce that blessed being a cube, with eight terminal points ? And in four dimensions shall not the motion of a divine cube result in a still more divine organisation with sixteen terminal points ? Behold the infallible confirmation of the series, 2, 4, 8, 16 : is not this a geometrical progression ? Is not this, if I might quote my Lord's own words,—'strictly according to analogy ?'

I ask is it not the fact that ere now your countrymen have witnessed the descent of beings of a higher order than their own, entering closed rooms, even as your Lordship entered mine without the opening of doors or windows, appearing and vanishing at will ?"

As the reward of his pertinacity he is precipitated back into Flatland, where his after-fates need not concern us.

Now all this, it may be said, affords no demonstration of polydimensional space and of the existence of beings able to see and act in such space. But it supplies us at least with a chain of analogies which the great principle of continuity bids us at least to deal with respectfully. It further proves why and how we cannot directly picture to ourselves space of higher dimensions than our own.

The mere possibility of such space—of a fourth dimension—is a serious consideration. We shall find on reflection that much which on the hypothesis of three dimensions as the only conceivable seems absolutely impossible becomes easy, whilst the very foundations of the more exact sciences will be found to be simply subjective, having their bases merely in the limitations of the percipient Ego. In this direction, be it remembered, all science is slowly but surely tending.

It seems to us impossible that any being should enter into a closed room having no aperture in ceiling, walls, and roof ; should see and describe the contents of a locked box or drawer without unlocking or breaking it open, and should take out certain articles and introduce others.

But the comparison with space of two dimensions will render such feats easy to a four-dimensional being. Let us suppose a Flatlander, a being with faculties something like our own, but possessing length and breadth only without thickness. We draw around him a continuous line in the form of square, triangle, circle, or other plane figure. It is obvious he cannot escape without rupturing the enclosure. Or, if we place him outside such a figure, he will be unable to see or in any way interfere with articles within the figure. Having no depth, and being incapable of rising above or sinking below his plane, either of which actions would imply a third dimension, he cannot look down into the supposed figure. On the other hand, a three-dimensional being, or perhaps we might better say a being capable of acting in three-dimensional space, experiences no such difficulty. He looks over, or steps over the *boundary lines* without interfering with them, and acts at his pleasure in their interior.

Now, by analogy, if a four-dimensional being exists, he will be able to pass into closed rooms or to see and touch articles in closed boxes, &c., without in the least interfering with their *boundary planes.* Just as one of us can enter a closed square or circle from a direction which to the supposed Flatlander would be invisible, inconceivable, and, indeed, non-existent, so the four-dimensional being would enter our rooms, our prisons, our locked chests from a direction perfectly open to him, though to us as "invisible, inconceivable, and practically non-existent" as in the third dimension to a Flatlander.

Nor would it be at all necessary that such a being, four-dimensional or *n*-dimensional, should be of spiritual nature. It may quite as well be material. That is to say its material frame would not in the least interfere with its power of performing in the most natural manner actions which we should regard as supernatural or miraculous.

Mr. Hinton does not consider that there is anything in the world as we know it which would indicate the possibility of there being an existence in four dimensions. But the evidence has scarcely been sought for. It is submitted that if a fourth dimension exists there are two alternatives: either, whilst there are four dimensions, we have a three-dimensional existence only, or, that our existence is really four-dimensional, but we are not conscious of it. If the former alternative be correct—if we exist in three dimensions only, while there really exist four or more dimensions—we are then, with reference to beings which exist in four dimensions, what lines and planes are in relation to us,—that is, —mere abstractions!

VI. SANITARY VAGARIES: THE NEW RIVERS' POLLUTION BILL.

By "Argus."

WHEN the sudden approach of danger finds John Bull, as usual, unprepared, he passes at once from heedlessness to panic, and adopts measures which certainly do not bear the stamp of sober reason. This rule has been fully verified by occasion of the recent—and perhaps future—approach of the Asiatic cholera.

The Metropolitan Board of Works, obliged to take some steps to correct the nuisance due to the discharge of sewage at Crossness and Barking Creek, but unwilling to adopt any really efficient means, came upon the costly and absurd scheme of pouring first chloride of lime and then sodium permanganate into the river.

Then, as a slight concession to common sense, they added these same chemical agents to the sewage as discharged! It is not too much to say that had the late chemical adviser to the Board, Mr. Keats, still been alive this expensive farce would never have been heard of.

In the course of the season Sir J. B. Lawes delivered himself of the profound suggestion that we should not seek to apply the sewage of our cities to the land, but should cheerfully carry it to the sea,—of course at an enormous outlay—in the hope that it will thence come back to us in the form of fish! It is needless to enquire what proportion of the organic matter in the sewage would be directly or indirectly eaten by food fishes. But I think the public will agree with me when I say that until the so-called "Bummarees" are completely improved out of existence feeding fishes will prove from a national point of view a very poor investment.

But even this scheme is outdone by the proposal of Prof. Henry Robinson, brought forward at the Dublin meeting of the "Sanitary Institute," and reported in the *Sanitary Record* for October last. This gentleman—an engineer if I mistake not—wishes to adapt clay lands for irrigation by digging it out to a depth of six feet, burning it into layers interspersed with an occasional layer of open alluvial soil. If such a plot is well drained it will, we are told, continuously clarify the sewage of 1500 to the acre. The cost of preparation, however, reaches, according to the proposer's estimate, to the modest sum of from £750 to £1000 per acre. Every one knows that such estimates fall far short of the actual cost of engineering schemes when reduced to practice. But let us take a town with a population of 300,000 persons —say Leeds. At 1500 persons per acre, we require then 200 acres of land, to be prepared at a first cost of £200,000! Nor is this all: Professor Robinson is of opinion that the larger particles in the sewage should first be removed by a process of ascending filtration and dug into low-lying land. Thus even if we assume that the acres stated will go on for ever purifying an unlimited quantity of sewage we must see that a very considerable annual extent will be incurred. Nor must it be forgotten that the plots of land thus "prepared" will be thereby converted into deserts, which neither art nor nature will be able to reclaim.

But I must hasten on to my main subject—the New Rivers' Pollution Bill. It may doubtless seem strange that the Act of 1876 should be repealed before it has had a fair trial and a new measure introduced in its stead. The old Act has not been successful, because the authorities have been remiss in putting its provisions into execution. Is there any reason to suppose that the enactment of a fresh law even every year would render them more zealous?

The new Bill has for its godfathers or godmothers Earl Percy, Colonel Walrond, and Mr. Hastings. Who are its parents is, of course, a secret, if an open one. Perhaps its appearance furnishes the key to the mystery why Dr. P. Frankland, last April, had the hardihood to disinter the peculiar views of the late Royal Rivers' Pollution Commission. It may easily be guessed who, and who only, must have felt uneasy at the omission of a certain notorious set of "Recommendations" from the Act of 1876.

To tell the truth, however, that Act is characterised by two grave omissions. It did not at all attempt to codify the law on the pollution of rivers. It was what lawyers, I believe, style a "cumulative" measure, that is, a law which provides new penalties and new procedures for certain omissions and commissions, but leaves all old statutes, laws, or customs bearing upon the particular subject still valid. A riparian proprietor who knows or fancies that a manufacturer or a municipal authority is polluting a river has still a choice of procedures. He may take action under the statute of 1876, or he may, I suppose, apply to the Chancery Division of the High Court of Justice for an injunction.

Now this power of option may be very convenient to a litigious person; or it may suit the purposes of certain lawyers. But it is, I submit, grossly unfair to manufacturers and to municipal authorities. Both are, surely, in common fairness, entitled to have open to them a clear, definite statement of what is legal and what is illegal as regards the pollution of rivers, so that they may know when they are obeying the law, and may feel that when so doing they are not open to any proceedings whatever.

Another defect in the Act of 1876, and in all existing law on the subject, has only been brought to light within a few months. The Law provides remedies in case of the pollution of any river, brook, lake, or other piece of water *open to the air and light*, but concerning underground waters it is silent. A brief explanation will here be necessary. A certain person, A. B., had within the limits of his property a well which supplied his household with potable water. On his neighbour's property there was also a well, disused as a water-supply. The said neighbour, however, took upon himself to turn the sewage of his house into the abandoned well. In due course of time the various kinds of polluting matter found their way through the intervening subsoil, and contaminated A. B.'s well. The latter took proceedings at law for the abatement of so serious a nuisance; but the judges, finding neither statute nor precedent bearing upon the question, were compelled to decide in favour of the defendant, as he had not broken the law.

Hence there are two open and palpable defects in the Act of 1876, and it might be naturally expected that in any attempt to amend, or rather to supersede, that measure, those deficiencies would not have been overlooked. Such expectations, however, if entertained, are delusive. On carefully examining the new Bill, as printed, I find assuredly no provision against the pollution of underground waters, and just as little any attempt at a codification of the law on river-pollution. On the contrary, it is distinctly laid down that—"The powers given by this Act shall not be deemed to prejudice or affect any other rights or powers now existing or vested in any person or persons by Act of Parliament, law, or custom; and such right or power may be exercised in the same manner as if the Act had not passed, and nothing in this Act shall legalise any act or default which would, but for the Act, be deemed to be a nuisance." Here, therefore, the notion of codification, as far as the language used is intelligible to other than lawyers, is distinctly repudiated.

I may be asked, What is the novelty of the new Bill, or on what can its claims to supersede the Act of 1876 be possibly based? The chief novelty which I can perceive is that the "Recommendations" of the Rivers' Pollution Commission are here introduced and adopted as "standards of purity." Is it then to be understood that the proposed measure is intended not so much to promote public health as to soothe the wounded feelings of the ex-Commissioners?

During the discussion which took place upon the reading of Dr. P. Frankland's paper the sanitary world was entertained with an account of the tenacity of life displayed by septic and pathogenic microbia. Whether the experiments on which the lecturer's statement was founded were fairly performed, or were conclusive, is not now the question. But the tenacity of life of disease-germs is trifling compared with that of the "Recommendations." They have been weighed and found wanting. They have been exposed to currents of calm critical inquiry and fried, so to speak, in derision. Yet in official brains—nowhere else—they still survive. Surely they are the most singular disease-germs ever known!

I may be told, as I am fully aware, that these "Recommendations" were proposed by a chemist of undoubted eminence, after careful and prolonged inquiry. I admit, most cheerfully, the eminence of the chemist in question, but I deny his practical sense and his power of freeing himself from "dominant ideas." It is written that this same chemist once applied for and obtained a patent for using common crystalline alum as a commercial source for the salts of potash! Can the absence of practicality be much more plainly shown?

I have been told by an advocate of the "Recommendations" that they would admit such water as that of the Irwell below Manchester. If this is the case, what more is needed to justify their rejection?

The great fault of the new Bill is that it pays no regard to the river itself, but looks merely at the quality—not the quantity—of the waters poured into it from manufacturing establishments, the sewers of towns, &c. If each of these emits abundance of water slightly within the proposed standards, the river, especially if small, will be brought to the condition of the Aire, the Calder, or the Irwell.

As concerns dissolved mineral impurities the Bill revels in inconsistency. It fixes a very stringent limit for arsenic, and to the neutral salts of soda, lime, and magnesia it gives free admission in whatever proportion. For all other metals it assigns one common limit—2 parts by weight in 100,000. Now, as the "Chemical News" very justly argues, some of these metals—such as chromium, lead, zinc, &c.—are formidable poisons, whilst others—such as aluminium and iron—are practically harmless in any proportion likely to find its way into a river. Surely then aluminium and chromium require each a different standard.

It is a mistake also to suppose that the unlimited introduction of the salts of sodium, calcium, and magnesium into water-courses is a matter of indifference to the health of man or beast. In my former article on the sewage-question ("Journal of Science," 1884, p. 256) I remarked that it was not demonstrated that "the carbonates and sulphates of lime and magnesia are detrimental to health." But I was here speaking of the calcium and magnesium salts only when in such proportion as they are naturally found in rivers, lakes, &c. Even the so-called mineral springs, though beneficial in certain diseases, are hurtful to men in a normal condition, and cannot serve as a domestic supply. How much less, then, should it be permissible to turn unlimited quantities of these salts into a river?

The fact is that, both as regards mineral and organic impurities, the Rivers' Pollution Commissioners laid down arbitrary standards which they have never been able or willing to justify.

But there is little occasion to go into a criticism of details. The fundamental principle of fixing a standard for the quality of waters which may, or may not, be permitted to flow into a river is vicious. All laws adopting it actually court evasion. If it is desired to turn into a stream some water which the standards would prohibit, nothing can be easier than to pump up water from such stream so as to dilute it to the degree needed. What, then, will be gained by the standards? As the "Chemical News" remarks:—"We trust that even the inspirers of this Bill will not be able to shut their eyes to the fact that whether we pour into a river daily 100,000 gallons of water containing 2 parts of organic carbon or 200,000 gallons containing half that proportion the total quantity of pollution conveyed into the river remains the same."

There may, and probably will, be found cases where the river is worse than the sewage or waste water discharged into it. In view of such cases the Bill declares that:—"It shall be no defence to any offence against this Act to prove that after any offence against the Act has been committed, the water of the stream is less polluted than is defined by the standards of purity hereinafter mentioned." I may add that should this Bill unfortunately become the law of the land it may happen that a manufacturer shall incur heavy penalties for turning into a stream water purer than the stream itself, if only such water in any one respect exceeds the standards.

Further still: If a stream is in any one point less pure than is required by the standards it will be an offence to take out a quantity of such water for any purpose and let it flow back again in its original condition.

It is not even certain that a manufacturer or a municipal body will be safe if they keep their waste waters within the standards. It is hard to say what snares may lie within the following provisions:—

"In proving any offence against this Act evidence may be given of repeated acts which taken together may cause such offence, although each act taken by itself may not be sufficient for that purpose." What may not, by the aid of able and unscrupulous counsel and unscrupulous experts, be construed into an infraction of the law!

It will be further evident from the very use of the terms "organic carbon" and "organic nitrogen," that any suspected water will be analysed by the processes employed in the laboratory of the late Rivers' Pollution Commission. The trustworthiness of this method may be judged by a reference to the specimens given in the "Journal of Science" (1884, p. 260). Who could feel easy knowing that in virtue of such analyses he may incur a penalty of £50 per day?

I further perceive that in Section C mention is made of "directing a person found guilty of an offence against this Act to use proper and sufficient modes and means, or *certain prescribed modes or means*, for the prevention of a pollution to any stream, &c." Does there lurk in these words an attempt to prohibit precipitation processes for the treatment of sewage and waste waters, and to force "broad irrigation" or "intermittent downwards filtration" upon the public?

Duly considering all these points I feel it my duty to warn all manufacturers and municipal authorities to oppose this Bill at every stage and by every means. Earl Percy, Colonel Walrond, and Mr. Hastings doubtless mean well, but they have fallen into the hands of untrustworthy advisers.

ANALYSES OF BOOKS.

A Treatise on the Principles of Chemistry. By M. M. PATTISON MUIR, M.A., F.R.S.E., Fellow and Prælector in Chemistry of Gonville and Caius College, Cambridge. Cambridge: The University Press.

FOR the first time since the formal installation of "the new chemistry" we have an attempt to supply the student with an English equivalent to Lothar Meyer's "Modernen Theorien der Chemie." The result of this praiseworthy and laborious undertaking is a philosophy of chemistry of signal value to the true student. The *true* student,—that is the man who seeks for something more than to store his memory with facts, more or less satisfactorily established.

Mr. Muir's fitness for his task will be at once admitted by such of our readers as have carefully perused his paper on "Recent Chemical Researches" ("Journal of Science," 1876, p. 30), and his memoir on "Scientific Method" (*Id.*, 1877, p. 476), whilst the spirit by which he is actuated may be judged from the motto which he selects for his title-page:—"In Nature everything is distinct, yet nothing defined into absolute independent singleness."

In proof of Mr. Muir's ability to distinguish true progress from mere change dictated by and ministering to a frivolous vanity, we may quote the following passages, which would have gladdened the heart of the late Hermann Kolbe. Speaking of the difficulty of expressing the "power of doing" of a compound in an intelligible formula, he writes:—"I call the student's attention to the kinetical aspects of the structural formulæ now used in chemistry, because I consider it of paramount importance that he should remember how little information these formulæ give in comparison with what we should desire to have; that he should not forget that the experimental methods by which these formulæ are obtained are for the most part kinetical methods, while the interpretation of the results is expressed in language which has grown out of almost purely statical considerations; and that while he recognises the vast importance of structural formulæ, he may still refuse to bow the knee to this chemical Baal which has been set up in these times, so aptly described by Remsen as the era of 'formula-worship.'"

Again he writes:—"I have tried always to exhibit the hypotheses of chemistry as at once arising from facts and serving as a guide in quest of facts. It is especially necessary to do this, I think, in dealing with the questions concerning structural formulæ. If these formulæ are dissociated from the chemical facts which they symbolise, they become intellectual tyrants; if each formula is considered simply as a summary of facts regarding the compound formulated, they are to be classed with the other 'brute beasts of the intellectual domain,' and cease to have much interest for one who believes that chemistry is a branch of science."

These passages may suggest serious reflections not a few. At present we will merely hint that the modern love for structural formulæ may be due to the contemporary examination-mania. The power of remembering "spread-eagles," reproducing them on the black-board, and expounding their supposed meaning is easily tested by the examiner,—one great duty of the "coach" being to ascertain what particular breed of spread-eagles any given examiner recognises in the only legitimate and *heilbringende.*

A prominent attribute of Mr. Muir, as it was of Kolbe, is his dislike of vagueness and looseness of thought and expression. Thus we find him writing:—"Much is to be expected from researches into the phenomena which occupy the border-land between chemistry and physics. If the knowledge chemists already have of the structure of molecules, meagre though that knowledge be, can be supplemented by definite dynamical conceptions, obtainable in part by the methods of thermal chemistry, then we may hope that chemistry will enter on a new stage of advance as a branch of the science of matter and motion. It seems to me that a most important step will be made if the bond-theory of valency is generally abandoned; with it will go all those quasi-dynamical expressions, the offspring of loose and slipshod ways of thinking, which have gathered round that strange anomaly a 'unit of affinity' employed as a variable standard for measuring nothing."

Further, in passing judgment upon Berthelot's thermo-chemical researches, our author says:—"Berthelot's work is saturated with the conceptions of the molecular; but by some fatal perverseness he refuses to apply this theory to chemical phenomena. While recognising the existence of molecules, and building his generalisation on a molecular foundation, he refuses to accept the conception of atom, or rather he hopelessly confuses it with that of equivalent. The molecule is for him a definite and definable portion of matter; the parts of the molecule are only numbers."

The periodic law is very fully and clearly discussed. It may, however, be doubted whether the merit of Mr. Newlands, in the initiation of this important generalisation, is brought into sufficient prominence. "Meyer's curve and its explanation are given. Carnelley's suggestion, that the fusibility of the elements varies periodically with their atomic weights, is discussed, and it is pointed out in a note that—according to the recent determinations of Nilson and Petterson—the melting-point of beryllium chloride is from 100° to 150° C. lower than the temperature assigned by Carnelley. Further developments of the periodic law, due to the researches of Hartley and Laurie, are also mentioned. The former chemist shows that the ultra-violet spectra of elements of the same series exhibit fairly-marked analogies in their general character. Still the spectra hitherto obtained do not warrant either the assertion or the denial of numerical relations existing between the different groups of lines, sufficient to establish a definite periodic connection between the atomic weights of the elements and the wave-lengths of the lines in the elementary spectra.

Laurie shows that there exists a distinct periodic connection between the atomic weights and the combining heats of the elements with chlorine, bromine, and iodine.

The author closes this chapter with the remark that it is interesting to observe in the periodic law "the survival,—perhaps rather the resurrection,—in a modified and more precise form, of the old conception of the element as an essence or principle capable of impressing on all substances into which it entered properties sufficiently definite to mark off all these substances from all others which did not contain this principle."

The author observes, concerning the "nascent" state and "nascent" action, that this expression has been at once helpful and hurtful. "By classing under a common head many phenomena which might otherwise have been lost in the vast mass of facts with which the science has to deal it has done good service. On the other hand, on the principle that

'Wo Begriffe fehlen
Da stellt zur rechten zeit ein Wort sich ein,'

its use has tended to prevent investigation."

In treating of chemical change and its conditions the author calls attention to the influence of mass. He insists, in passing, on "the importance of considering the relative masses of the reacting bodies in all processes of chemical change, and to remind the student that this factor is almost universally ignored in our ordinary chemical equations."

The questions of the origin of the elements, of their possible decomposition or their mutual transformation, are not taken into account. The author—not without grounds—doubtless holds that such speculations are metachemical rather than chemical, and that the time for their definite solution cannot be said to have arrived.

In examining Mr. Muir's work we have been insensibly led, instead of giving a connected analysis of its teachings, to call attention to his views on a number of the most important subjects in the philosophy of the science. These considerations, though of necessity somewhat fragmentary, will, we hope, bring the merits of the book into a sufficiently clear light, and justify the reader in undertaking its connected study.

The Round Table Series. IV. *Walt Whitman, Poet and Democrat.* By JOHN ROBERTSON. Edinburgh: Wm. Brown.

NEVER did we take up a book with so much hesitation and diffidence as the one before us. To our best knowledge the author has not in any way come in contact with the interests which we represent. Unlike many poets and literary men of the present century—we need only mention, Campbell, Keats, Elliott, and Tennyson—he has not even sneered at Science. Of his writings we have encountered nothing beyond a few extracts and reviews, which have escaped our memory, and what is to be found in the present treatise.

The subject of Mr. Robertson's exposition is described on the title-page as " Poet and Democrat." Now we have little sympathy with democrats, or indeed with " crats " of any kind. We would not here be misunderstood. We do not necessarily avert our eyes from, and close our ears to, a man because he has decided political opinions, nor even because he seeks to enforce such opinions. But the man who is essentially a " crat "—who cannot be truthfully described if we leave his " crat "ism on one side—is as much outside our mental sphere as is Sulitelma, or the Table Mountain, at the present moment outside the range of our eyesight.

Mr. Robertson tells us that " his [Whitman's] is the naïf popular Theism of the day, which finds the universe made for man, and the land for the race." Is this creed, the unphilosophic version of the old aphorism " Man the measure of all things," in need of any new preachers and advocates? Should it not rather be zealously unpreached? We fear that one of the tendencies of the " fanaticism of democracy," to quote Mr. Robertson's expression, will be a return to the great Socratic apostasis, —that is, an attempt to turn away attention from external nature to man.

Against such a tendency we must earnestly protest, feeling that there is more salvation for our race in the labours of the student of physical and natural science (*e.g.*, eugenism) than in all the jugglery of franchise-mongers, and all the frothy talk of the moral societies.

We read—" But Whitman is in nothing more remarkable than in the exaltation, the fervour with which he sings of love between comrades. . . . His faculty of brotherly love is one of his most potent inspirations." Brotherly love is a very questionable feeling. One of the most objectionable types of the drunkard is he who, as he reels home, insists on shaking hands with everyone, and who is ready to quarrel with all who decline to touch his beer- and tobacco-scented paw. The first French Revolution was intensely brotherly when it exclaimed "*La fraternité ou la mort.*"

Whitman is described as self-esteeming, vigorously egotistic, intolerant. Now it is noteworthy that at present there exist not a few minds of this stamp, who, whilst advocating the claims of the individual against the community, would proscribe every form of activity but their own. French democracy, when handing over Lavoisier to the headsman, declared that the Republic had no need of chemists; the Corn-Law rhymer, Ebenezer Elliot, is unmeasured in his contempt for the working-class naturalist; and modern English organs of popular opinion "were instant with loud voices" that no part of the surplus from the Fisheries' Exhibition should be applied to fitting up marine zoological stations. And these voices, whether or not backed by those of the chief priests, prevailed.

It is remarked by Mr. Robertson that Whitman "is never heartily humorous in his writings," and that he even "sees in the American habit of jesting on all things one of the unhealthy aspects of things democratic." We do not know whether this tendency is exclusively American or purely democratic. The kings and barons of the Middle Ages had their official "jokers of jokes." We in England generally contrive to have at least one circus-clown in our Parliament. But perhaps the democrat, as he is his own sovereign, thinks it necessary to be his own court-fool at the same time. Yet even if the tendency to perpetual joking is world-wide it needs a rebuke, and that such should come from America is all the better.

Of poetical merit we are certainly no fitting judge; but we may at least ask whether a contempt for rhyme, for rhythm, and for grammatical accuracy is of itself sufficient to constitute poetry, especially in the absence of great thoughts?

The following passage, due, as the reader might well suspect, not to Whitman, but to Mr. J. Robertson, deserves serious consideration:—"People profess to believe in Evolution, yet treat every new speculation as less an error than a crime." At least let Whitman, his morals and other respects being granted irreproachable, receive from cultured men the tolerance with which they view the domestic transactions of Socrates and the social doctrines of Plato.

But what of the following?—"The disciplined thinker who believes in democracy and progress would fain that the poet had arrived at a fuller system of thought,—that Whitman had been

Comte." Surely one Comte has been something more than sufficient.

Concerning the ability with which Mr. Robertson has handled his subject there can be no dispute; but we could have wished him a worthier task.

Journal of the Royal Microscopical Society. Containing its Transactions and Proceedings, and a Summary of Current Researches relating to Zoology and Botany (principally Invertebrata and Cryptogamia), Microscopy, &c. Edited by FRANK CRISP, LL.B., B.A., &c. Series 2, vol. 4, 1884, pp. 1008. Published for the Society. London and Edinburgh: Williams and Norgate.

THE present volume, as is the case with its predecessors, in the present series contrasts strongly with the two small books issued during the early years of the then Microscopical Society of London and containing a selection of papers read before it, few in number indeed, but by such eminent pioneers as Dr. Bowerbank, Dr. Carpenter, Professor Owen, Edwin and John Quekett, Cornelius Varley, Rev. J. B. Reade, and other well known names in the list of microscopists. As the Society increased, so its publications grew, and now, forty-four years after its foundation, form a goodly array, containing a perfect treasury of histological research.

The origin of this now influential society was small like the early volumes of its transactions. About the year 1828, the late Mr. J. S. Bowerbank became the possessor of one of the then famous microscopes constructed by the late W. Tulley, of Islington; although the objective of this instrument was only a triplet of about nine-tenths of an inch focus, and constructed somewhat after the manner of the object glass of a telescope, its performance was far superior to any microscope at that time procurable, and as not more than four or five were then in existence, many persons resorted to Mr. Bowerbank's house to confirm their observations by means of the new instrument. These visitors became so numerous that at last it was necessary to set apart one evening in the week, and Mr. Bowerbank's Monday evenings were for many years noted for their interesting character and the number of eminent men frequenting them. As to the difficulties observers met with in those days, it is hard to realise them now, when everything is so easily procurable; glass slips had to be cut by the observers themselves; thin glass covers were unknown for some time. The best of microscopes could probably be now surpassed by some costing about five pounds, and mounting in balsam was a new invention. From these social gatherings the Microscopical Society of London originated ; a meeting was held on the 3rd of September, 1839, and the society formed. More than forty years have elapsed, and not one of the seventeen founders are now living. Prof. Owen was elected the first president in 1840, and has been followed by a succession of eminent microscopists down to the present time. The Monday evenings continued for some years longer, and served admirably for the purpose of recruiting the new society. They were only discontinued when their amiable founder ceased to reside in London. The work of the Microscopical Society of London was continued under that name until 1866, when a charter of incorporation was granted, and the society, receiving the patronage of His Royal Highness the Prince of Wales, became the "The Royal Microscopical Society."

Former notices have frequently called attention to the unique character of the "Journal of the Royal Microscopical Society," which, unlike most learned societies, does not confine itself to the publication of its own transactions, but gives a very complete abstract of all that is taking place in its own departments of science. It will suffice to say that the present volume is fully equal to any that have gone before it, and bears testimony to the activity of the society and the energy of the editor and his talented staff of assistants. The volume is well indexed, as is the case with the whole of the present series.

Considering the great extent of the past publications of the society and the valuable matter contained in them, it is to be hoped that they may some day be rendered more easy of reference by the publication of a general index.

Natural History Sketches among the Carnivora, Wild and Domesticated, with Observations on their Habits and Mental Faculties. By ARTHUR NICOLS, F.G.S., F.R.G.S. London L. Upcott Gill.

WITH this work we are not quite satisfied. Above two-thirds of the whole are devoted to dogs—a somewhat thread-bare subject, —except from a psychological point of view. Twenty-eight more pages are bestowed upon the domestic cat, leaving only forty-three for all the wild carnivora, about which there is greater need for further accurate information. The author has evidently enjoyed very extensive opportunities for observation. He places on record too a goodly number of interesting facts, though he seems to regard the animal world rather with the eye of the sportsman than of the true naturalist.

His accounts, like all others, of the size of the Bengal tiger are of necessity vitiated by the absurd practice of tiger-hunters, of measuring their slain opponents from the tip of the nose to the tip,—instead of to the root of the tail. This custom renders the recorded dimensions valueless for indicating the real size of the animals.

Reading further, we find a reference to the abominable crime of tiger preserving. We may laugh at, whilst we regret, the folly of the Hindoo peasant who holds the tiger in superstitious reverence. But the civilised (?) European who spares the cubs of this enemy of man that he may afterwards display his courage and skill in shooting them when mature stands on a yet lower level, and is constructively a murderer. Surely the necessary extirpation of the tiger might be much facilitated by the use of poisoned bullets.

A strange fact concerning the leopard is mentioned on the authority of Sir Emerson Tennant. They have, in Ceylon at least, a peculiar fancy for the flesh of persons suffering from small-pox, by the specific odour of which, they are, it seems, strongly attracted.

Mr. Nicols seems to have come into unpleasantly close contact with the skunk in South America, and describes his sufferings on the occasion most graphically. He estimates the distance to which this animal can eject its dreadful secretion as fully ten feet. The common assertion that the mungoos is endowed with a special immunity from the venom of the cobra, or that it has recourse to some antidote, he disproves by reference to an actual experiment, which, as it was made with a scientific object, will be in certain quarters ranked amongst "orgies of diabolism."

The author quotes the statement made by Mr. Lawson Tait (in a paper read before the Birmingham Philosophical Society in 1883), that no other animal but the cat is subject to congenital deafness, and only those that are white are so affected.

This assertion was made too hastily. Dr. S. W. Burnett gives two instances of dogs deaf from puppyhood—one of them, moreover, not white but yellow.

Mr. Nicols denounces, not unjustifiably, the numerous persons who go off for a month or more to the seaside, leaving an unfortunate cat to starve or thieve. The number of these homeless cats is, in London, very considerable. On this subject he writes:—"Here is a clear field of action for the opponents of experiments upon living animals for the purpose of physiological research. Without a doubt more cats die annually in London of starvation than in all the physiological laboratories in the world, and they die a terrible death in consequence of the selfishness of those who are responsible for their well-being. Unfortunately, however, the case of these tortured cats does not present features which lend themselves to sensational or picturesque effects in advertisements and pictorial wall-posters, and would not either arrest attention or draw subscriptions."

This appeal might shame some of our Bestiarians were they consistent in ought save inconsistency.

Although a cynophilist, or even as our contributor, Frank Fernseed, would term him, a cynolater, the author is more reasonable than some of the fraternity. He admits that the barking of dogs is a rampant nuisance and a "source of serious distress to brain-workers, and of imminent danger to the sick." He considers that "there ought to be a more prompt method of restraining the offending owner from inflicting the barking-torture upon his neighbours than is now obtainable." He owns that remonstrance with the owner is "generally met with insult, always with indifference.

But whilst fully aware that no man has a right for his private gratification to inflict such serious annoyance upon his neighbours, we cannot agree with Mr. Nicols that it is only chained dogs which make day and night hideous with their yelps and howls, and that they might be cured by allowing them more exercise. Going along Tottenham Court Road we were once obliged to turn aside into Gower Street because a little dog persisted in running yelping after every passing omnibus. More than once we have had to get out of a tram-car before our journey's end because some dog-owner had taken his seat in the vehicle, whilst his "base tyke" ran along by the side of the horses, barking incessantly.

The following passage is certainly outrageous:—"A human being who has not at some period of life enjoyed the friendship of a dog has missed one of the most humanising of all influences. Almost all the best men and women I have known were indebted to association with their dogs for much of that which is best in their character and disposition." Our experience and observation lead us to a very different conclusion.

Museums of Natural History. A Paper read before the Literary and Philosophical Society of Liverpool, by the Rev. H. H. Higgins, M.A. Also a *Phylogenetic Scheme of the Pedigree of Animals and Vegetables.* By Prof. Herdman. Liverpool: D. Marples and Co.

Were we to refer to every part of this pamphlet which richly deserves notice our critique would be bulkier than the treatise itself. Eschewing therefore all preliminaries, we perceive that the author divides visitors to Museums into three classes,—Students, Observers, and Loungers. The former, whom he approximately estimates at 1 to 2 per cent of the total, are those who come with a definite purpose of improving their knowledge of natural productions, or, as it might be put, who seek the solution of questions which have occurred to them during reading or reflection.

The observers, who may reach 78 per cent, have no conscious, definite purpose, but "fix their attention with more or less intelligence on the objects displayed." The loungers reach, in Liverpool, 20 per cent, though in South Kensington they would doubtless be relatively more numerous.

The author concludes that "observers are more numerously attracted by the birds than the invertebrate animals. These proportions are reversed in the case of students."

The first part of the pamphlet closes with a recommendation for curators to organise. The following quotation from the late Prof. Stanley Jevons should never be forgotten:—"I venture to suggest, in conclusion, that the best possible step which could now be taken to improve the museums of the United Kingdom would be the constitution of a Museum Association on the lines of the well-known Librarians' Association. If the curators of all the public museums would follow the example of other professional bodies, and put their heads together in a conference, they might evolve out of the existing chaos some unity of ideas and action. At any rate they would take the first important step of asserting their own existence. There have been enough of Blue-books and Royal Commissions, and we have heard too much of what 'my Lords' have got to say. Let the curators themselves now speak and act, and let them especially adopt as their motto—Union, not Centralisation." Admirably said; but in all museums which are in any way connected with the Science and Art Department, the motto will be—Centralisation, not Union. Too often, also, attempts at professional organisation have resulted mainly in the establishment of a new set of examinations!

In his second part Mr. Higgins discusses "Museum Desiderata." He complains, with justice, that "many museums, in which the collections are fairly adequate, are rendered almost worthless to the public by deplorable deficiencies in the naming of the specimens: either the labels are inaccurate or altogether absent, or the ink has faded, or the writing is small and illegible; or the vibrations set up by the feet of visitors have severed specimens and their names into a most perplexing remoteness; or the objects are crowded, overlapping each other and concealing the names; or the label omits the locality where the specimen has been obtained."

In large families, containing many genera, the matter is still worse:—"Where the group begins and where it ends, what characters bind it together, what are its neighbours, and what the habits of life distinguishing its constituents, might be matters of complete indifference in some museums." In short, the author very sensibly recommends, as a means of rendering the museum instructive, the use of conspicuous tablets calling attention to the life-history, affinities, and geographical distribution of the groups. The dusty, neglected look of the specimens is another legitimate cause of complaint.

Mr. Higgins denounces also a piece of vulgar obtrusiveness which we, too, have remarked with high displeasure. "A friend recently informed me that he saw in a museum, representing the regard for natural science in a wealthy county, a glass-case containing, together with specimens of natural history, a *remarkably small pair of breeches* worn by a foreign nobleman who had not long before resided in the district." Any comment on this absurdity would be an anti-climax. Hence Mr. Higgins is guilty of no paradox when he remarks that it is "the chief duty of the managing committee to keep such things out of their museum."

The author further rightly considers that no museum is complete without a biological laboratory, which should be near to, though not containing, the marine and fresh-water aquaria. The laboratory should be the receptacle for all specimens which cannot be properly examined without the aid of the microscope.

In the section dealing with museum arrangements Mr. Higgins admits that "if a genealogical tree were traced upon the floor, and table cases with glass tops for typical specimens were put in places indicated by the furcations of the classes, an exceedingly interesting appliance for giving instruction would thus be constituted." At the same time he is fully aware that to carry out this plan would require a very large space; not to speak of the difficulties arising from our hitherto imperfect knowledge of the phylogeny of animals.

The lack of space and funds is also the reason why even our great national museum has not yet attempted to form, along with its systematic collection, a second zoo-geographical collection, giving the leading features of the fauna of each country.

We find next a sketch of some of the relations in which invertebrate groups may be illustrated in a museum:—

"1. General life-history, including such information pertaining to the group as may serve to distinguish it from allied groups. This illustration may take the form of a tablet, printed in large type.
"2. The body of the group, consisting of specimens typical of the families, genera, and species constituting the group, preference being given to the most beautiful and most significant forms.
"3. British species representative of the group.
"4. Fossils showing the earliest appearance of the group in geological time.
"5. Specimens and anatomical preparations of members of the group preserved in liquids.

"6. Specimens of nests and habitations, galls and their tenants, eggs and egg-cases, webs and tissues; larvæ and pupæ; timber and stone pierced by molluscs, Crustacea, and insects.

"7. Examples of mimicry; of protecting colouration of unusual contrast between male and female of the same species; malformations, &c.

"8. Extended series of species and varieties belonging to the group, to be seen on application to the curator.

"9. Economic products of the group used in manufactures and arts. [Would not this department belong rather to a technological or industrial museum?]

"10. Models, drawings, diagrams, &c., of the anatomy and embryology of animals belonging to the group.

"11. Schedule indicating the systematic position of the group in the sub-kingdom to which it belongs.

We surely need not bring any formal proof that a museum embodying these features would be far more instructive to the student and the observer than anything which has yet been realised.

Passing over much suggestive matter we come to the author's remarks on the British Museum in its splendid place of exile. Following upon his first impression "how vast a work has been done!" comes a second, "at least equally strong, how much remains yet to be done! And a concluding conviction might perhaps follow—how much has been left desirable which can never be done, or only with extreme difficulty, in the present building. Whatever may be the architectural merits of the edifice very much has been sacrificed to them."

We must beg leave to expand this remark. The impression prevails among outsiders that in the new building in Cromwell Road—why not better Darwin Road?—ample space for every department is secured. This is quite a mistake. Nothing can be a piece of greater folly than to sacrifice the efficiency of such a place to architectural display.

> "The walls are thick, the servants thin,
> The gods without, the devil within,"

has been long ago pronounced to be the common condition of museums. To some extent these lines are applicable to the new building.

The curators are too thin in point of numbers. The extensive department of Entomology, for instance, is committed to the charge of *three* curators only! We know these gentlemen personally, and can testify to their zeal and efficiency; but they are too few.

Mr. Higgins, preferring a plain building with ample space to the palatial structure in question, writes:—"I fear the West End requires to be educated before it would endure such a structure placed permanently so near Belgravia." Precisely; and this is one of the many reasons why the Museum should never have been taken to South Kensington.

One of the reasons alleged for this ill-starred removal was to give sufficient room for specimens of whales, &c. But where are these animals placed now? In a hall where the view is broken by massive brick pillars!

Mr. Higgins's pamphlet must commend itself to all sincere votaries of natural history, and we hope that all such will give it a careful reading.

A Treatise on Gold and Silver. To show a Chief Cause of Present Depression in Trade, and Shrinkage in Value of all Produce and Property. By GEORGE O'BRIEN. Dedicated to the Right Hon. W. Ewart Gladstone, M.P. London: Mining Journal Office.

THE object of Mr. O'Brien is, firstly, to inquire whether the amount of gold in circulation throughout the world is sufficient for the requirements of commerce, and whether we can increase the supply? For this purpose he enters upon a close examination of the auriferous districts throughout the world. This survey is not, it will be observed, such a one as could be got together by a mere reader. The author is practically acquainted with the natural distribution of gold in such important districts as California, Nevada, the Wynaad, and, we believe, Peru and Bolivia. As gold, so far, has been found under identical conditions wherever it occurs at all, we may trust his judgment even concerning regions which he has not personally explored. He shows that our stock of gold has been chiefly derived from alluvial deposits, which in course of time have become much impoverished, if not exhausted. Many of these deposits have been worked profitably only by means of slave-labour, and now, in spite of all the devices of modern science, the output is gradually falling off.

It is a somewhat singular circumstance that the elements of highest specific gravity, such as gold, platinum, and iridium, should exist chiefly in superficial deposits. We can only account for this fact by supposing that they were primordially deposited, alike in profound and in superficial strata, in traces too minute for profitable working, but that these particles have been liberated during the weathering of the surface formations, and have become agglomerated.

Beginning with that collapsed bubble, the Wynaad, on which we learn that above three millions of British capital have been fruitlessly spent, the author passes on to the other reputed auriferous districts of Asia. The produce of China and Japan he estimates at about £750,000 sterling yearly, and points out that as the people of those empires are very skilful in gold-finding and washing, the probability of any important deposits having escaped them is not great.

The yield of the Russian empire shows a gradual, steady decline. The net produce in 1877 was only £661,500, and since then it has continued to fall off.

Africa still yields about £1,300,000 annually, Here, also, there is every probability that the richest alluvials have been ransacked and washed out. The different regions of South America have been at one time enormously productive; but now they, for the most part, exhibit the same picture as the Wynaad and the auriferous districts of Siberia. During the (approximately) two centuries from 1691 to 1884 Brazil has yielded gold to the extent of £150,000,000; its present output is under a quarter of a million. New Grenada and Venezuela yield about £200,000 yearly. Mexico, too, has greatly fallen off.

Even California, Nevada, and certain adjacent States of the North American Union, which in the thirty years from 1849 to 1879 contributed £327,000,000 to the world's stock of gold, are not now as productive as in those days. In 1881 the output of all the States combined had fallen to £4,700,000, with a prospect of further decline. In British North America the production of gold has often been close upon a million yearly, but is now falling off. In Australia the yield does not reach the half of its quantity in 1867.

In short, our author sums up the total yield of gold throughout the known world at £14,000,000, and this with little or no tangible prospect of increase. It is further shown that of this small yearly total £9,000,000 are consumed in jewellery, gilding, &c., and that no small portion is, especially in America, buried with the dead in the fastenings of artificial teeth. Thus for the purposes of commerce there remains only the relatively small sum of £5,000,000.

To meet this evil the author proposes the adoption of a bimetallic currency, or, in other words, the recognition of silver as a legal tender. We are no commercial or economical authority, but to us his arguments seem sound and his proposal eminently judicious. He points out the significant fact that the epoch of the profuse gold yield in California and Australia, from 1849 to 1879, was a time of unexampled commercial prosperity,—a time when national prosperity was increasing by "leaps and bounds." On the other hand, the present stagnation of trade, whatever other causes may concur, is certainly connected with a falling off in the supply of that metal which the modern world has chosen for its sole circulating medium.

The Unity of Matter; being Thoughts on the Nature, Weight, and Expansion of Gases. By G. T. Carruthers, M.A.

This treatise will scarcely fulfil the expectations which chemists will draw from the title. Any evidence, direct or indirect, that all matter is derivable from some one elementary substance they would eagerly welcome; but this is so far not forthcoming. The author certainly accepts material unity. He writes:—"If there is a Creator of matter are we to suppose that He called into being, one by one, all these elementary forms, and some of them in such minute proportions to the immense masses of others that the reason of their existence becomes as great a mystery as their creation?" With the view here expressed most chemists will agree. But in a following passage they may justly complain that their notions are not fairly represented; for we are told that moderns "find no difficulty in accepting the idea that there are sixty or seventy primitive forms, each having inherent and marvellous properties of its own."

Such, we submit, is by no means the case. Few, if any, chemists now regard the elements as other than bodies which so far we have been unable to resolve into anything simpler. The primordial unity of matter they accept as firmly as does Mr. Carruthers. They do not refuse to "accept the notion of the unity of matter because it is not supported by experiment." They look upon such unity as highly probable, though not proven, and they eagerly look out for convincing evidence, and will not be slow to accept such if found.

Mr. Carruthers suggests that chemists may perhaps think as follows:—"There are sixty or seventy centres of creation or centres of matter in the universe. The vapours issuing from these fill space, and so interpenetrate each other that the planets appropriate and condense proportions of them all as they proceed in their orbits. Thus the Earth, the abode of oxygen, steals its nitrogen from Mars, which is ruddy with its nitric peroxide; Venus shines bright with its inherent carbon and the Earth's oxygen, while the Sun is the great source of hydrogen."

We question if this speculation has ever before been propounded. It certainly presents at every step suppositions which are, to say the least, unproven.

Mr. Carruthers considers that, in seeking to decompose the elements, we have kept "blundering on, trying to simplify that which is already simple; but it may be wiser to try to arrive at the unity of matter by some other process. Let us then, leaving the simple forms, take one of the so-called compound forms of matter, and, instead of splitting it up into its elements, try rather to raise upon it all other elements. Let us, for instance, take water. We know that if we place in water the terminals of a battery, two so-called simple substances will issue from it:

now why may not these be only two other forms of watery matter? It is possible that they may each contain exactly the same constituents as water, but have different properties because they contain the watery constituents in widely different proportions." And the treatise concludes with the words—"Until we know more it is well to contemplate the possibility of water being the only simple in the world, and the original matter of the universe."

Yet the author, in the passage quoted above, speaks of water as having "constituents,"—identical with those of oxygen and hydrogen, but in different proportions. In a further passage he supposes that "water is formed of some vapour and some absorbing solid"—and yet simple! Here, then, oxygen and hydrogen are set aside in favour of two hypothetical bodies as unseen and unproducible as the andronie and thelyke of Winterl.

Water has been subjected to innumerable experiments, but nothing save oxygen and hydrogen has ever been obtained from it. Hence we may well question the wisdom of "blundering on" in this direction. By whatever process we decompose water the results are qualitatively and quantitatively the same: hydrogen and oxygen, free or in combination, are produced; and from such hydrogen and oxygen, in the same proportions, water is again obtained. If we set aside this double evidence we reject analysis and synthesis as means for ascertaining the composition of any substance. Thus it might be asked, Why may not potassium and oxygen be merely other forms of potassic matter? Why may not mercury and oxygen be merely other forms of mercuric oxide matter? In short, we pronounce experimental inquiry a sheer impertinence.

The author's further reasonings contain much in which we can find nothing definite and tangible. If he is ever able to produce any experimental fact proving the origin from pure water of anything save oxygen and hydrogen, he may rely upon our respectful attention.

First Annual Report of the Bureau of Ethnology to the Secretary of the Smithsonian Institution, 1879-80. By J. W. POWELL, Director. Wasington: Government Printing Office.

THE interest taken in ethnology in the United States is a healthy feature. Here is a subject totally unconnected with money-making, and pursued, if at all, from the pure love of truth. The goodly volume before us contains, in addition to the Directors'

Report, papers on the evolution of language, on the mythology of the North American Indians, on the Wyandot Government, and on limitations to the use of some anthropologic data, all by Mr. J. W. Powell. There are, further, a study of the mortuary customs of the North American Indians, by H. C. Yarrow; studies in Central-American picture-writing, by E. S. Holden; an essay on the cessions of land to the United States by Indian tribes, by C. C. Royce; sign-language among North-American Indians, by Garrick Mallery; a catalogue of linguistic MSS. in the library of the Bureau of Ethnology, by J. C. Pilling, and illustrations of the method of recording Indian languages, by J. O. Dorsey, A. S. Gatschet, and S. R. Riggs.

Some of these papers merit an examination in detail,—at greater length, indeed, than our available space will allow. In the essay on the evolution of language Mr. Powell discusses what he calls the " grammatic processes," by which an original small stock of words has been combined and modified. These processes are: combination, vocalic mutation, intonation, and placement. The author next discusses the differentiation of the parts of speech. He insists that all paradigmatic inflection in a civilised tongue is a survival of a barbarous condition. All such inflection requires unnecessary thought. In the clause *if he was here*, *if* fully expresses the subjunctive condition, and it is quite unnecessary to express it a second time by using another form of the verb *to be*. And so the people who are using the English language are deciding, for the subjunctive form is rapidly becoming obsolete, with the long list of paradigmatic forms which have disappeared."

He further writes:—" Every time the pronoun *he*, *she*, or *it* is used it is necessary to think of the sex of its antecedent, though in its use there is no reason why sex should be expressed, say, one time in ten thousand. If one pronoun non-expressive of gender were used instead of the three, then in 9999 cases the speaker would be relieved of an unnecessary thought." Judging by such criteria he considers that the English language stands alone in the highest rank.

The same author in his sketch of the mythology of the North American Indians studies the genesis of philosophy. He holds that there are two grand stages of philosophy—the mythologic and the scientific. In the former of these stages all phenomena are explained by analogies derived from human experience. " By subjective examination discovering in himself will and design, and by inductive reason discovering will and design in his fellow men and animals, he extends the induction to all the cosmos, and discovers in all things will and design. All phenomena are supposed to be the acts of some one, and that some one having will and purpose. . . . The simple is compared with and explained by the complex." In the second great stage phenomena are supposed to be the children of antecedent phenomena. . . . Man, with the subjective phenomena gathered about him, is studied from an objective point of view. . . . Thus the complex is studied by resolving it into its simple constituents." Here we find it incidentally remarked that "blue and green are not differentiated, for the Indian has but one name for the two." But are we thence to infer that his perceptions of colour are not differentiated? We civilised men have not names for one-tenth part of the colours which we can perceive and distinguish.

According to Mr. Powell the mythologic philosophy, has four sub-stages. In the lowest of these, *hecastotheism*, everything is alive and everything is a god.

In the second stage, zootheism, animals are gods. "No line of demarcation is drawn between man and beast." We may here remark that this very line of demarcation afterwards drawn in the following stage became one of the cardinal errors which Evolutionism has to eradicate.

In the third stage the powers and phenomena of nature are personified and deified. Thus there is a sun-god, a moon-god, &c. This stage Mr. Powell names physitheism.

Lastly, mental, moral and social attributes are personified and deified. This stage, in the author's system, is psychotheism. By a process of mental integration it developes in one direction into pantheism, and in the other into monotheism, according as the intellectual or the moral element predominated in the minds of the men by whom the process of evolution was carried on. It is a curious fact that the rise of psychotheism appears to have been conincident in time with the invention of an alphabet.

Certain outgrowths of the mythologic philosophy are next considered. The first of these, which the author designates "ancientism," is the belief that "yesterday was better than to-day, and that the ancients are wiser than we."

Another of these outgrowths is affirmatisation,—the propagation of opinions by affirmation. What has been often or always said,—what is said by everyone,—must be true.

Very few people will now uphold "ancientism." But it may be asked whether its modern substitute "progress" is not a mistake equal and opposite. What is new is no more necessarily true than what is old. Evolution is often of a retrograde character and leans to degeneration.

In the paper on the mortuary customs of the Indians we find that certain tribes have the abominable habit of burying their dead under springs, or throwing them into lakes and rivers. An African tribe, the Obongo, bury their deceased friends in the bed of a stream which is temporarily diverted from its normal course.

In the essay on sign-language we find it recorded that Prof. A. Graham Bell succeeded in causing a terrier to form a number of the sounds of our letters, and to utter distinctly the words "How are you, grandmamma?" We dissent from the author's opinion that the brain of the parrot is not sufficiently developed to admit of its vocal powers being used significantly. We have personally witnessed decisive instances to the contrary.

Mineral Resources of the United States. By ALBERT WILLIAMS, Jun. Washington : Government Printing-Office.

ONE of the most interesting sections of this book is that on the Divining-Rod, by R. W. Raymond.

Concerning this instrument and its value the most conflicting opinions prevail among its votaries. Not only are its shape, size, and mode of use matter of dispute, but on its range of efficacy there is no agreement. " The immense literature of the divining-rod shows nothing more clearly than the boundless contradictions and confusions of its advocates and professors." In antiquity the rod was used mainly for moral purposes, that is for the detection of criminals, the foreknowledge of future events, &c. In the middle ages its employment was restricted to the discovery of hidden treasures, of veins of ore, springs of water, &c., whilst its former function was condemned by the Church. Towards the end of the seventeenth century its moral efficacy was again asserted, and in the eighteenth it was once more relegated to the material sphere. That its advocates occasionally fell under the censure of the Church is very intelligible, though this does not seem to have occurred as long as they confined their operations to the detection of material objects. Its use was, indeed, sometimes accompanied by rites of a magical character. . Others held it essential that the rod after being cut must be consecrated by being placed in a bed along with a newly baptised infant, whose name it received. The author quotes from Gaetschmann the following formula addressed to the rod :—" In the name of the Father, and of the Son, and of the Holy Ghost I adjure thee, Augusta Carolina, that thou tell me, so pure and true as Mary the Virgin was, who bore our Lord Jesus Christ, how many fathoms it is from here to the ore ?" The rod was then expected to dip as many times as the ore lay fathoms deep.

It is undeniable that " dowsers," as they are called in Cornwall, have often been successful, especially in discovering deposits of ore, subterranean water-courses, &c., in districts with which they are familiar. But even in such districts their failures are many. When their power is put carefully to the test, it generally fails. " The most distinguished expert in this art on the Pacific coast . . . was invited to inspect a metallurgical laboratory containing a large amount of gold in coin and bullion. After this inspection he was brought again, blindfolded, into the laboratory, and requested to point out the metal with his rod. But he could find nothing, though during his perambulation the point of his rod was frequently within an inch of thousands of dollars." But he had an excuse at command. "When the bandage was removed from his eyes and he was shown that all the coin had been put in the fire-proof safe, while all the bullion had been fastened by wire to the underside of a writing-table, he claimed that his rod had been diverted by the immense amount of treasure in a bank half a block distant!"

The author gives other instances of failure and of fraud among these diviners. He then sums up the matter in the following series of propositions :—

"The material, consecration, astrological relations, and ritual formalities of the rod are entirely irrelevant and indifferent to its efficacy. The rod is entirely inert, unless in the hands of a human operator, and . . . is merely an index revealing in visible results the peculiar inward sensation of the diviner. The favourite and most convenient form of the rod (Y) is one which promotes involuntary muscular movements, and permits deception.

"The uses of the rod for discovering moral qualities, restoring missing landmarks, tracing stolen property, predicting the future, or even settling the orthodoxy of theological dogmas belong to charlatanry and superstition.

"The agency of demons we may also set aside, as a view outgrown if not disproved. [This can scarcely be asserted with as much confidence now as was the case half a century ago.]

"The application of the rod to the discovery of metals, coal, buried treasure, &c., is shown abundantly to be chimerical. The rules and methods, as well as the asserted performances of its professors, contradict each other, and innumerable failures and exposures have justly covered their pretensions with ridicule.

"The transparent humbug of locating oil-wells with the rod needs no comment.

"The case is somewhat different with the discovery of springs, and (since ore-deposits always have been the channels of springs) of ore-deposits. Here we have much stronger and more abundant evidence in favour of the rod, and here, in my judgment, there is a residuum of scientific value."

On this head Mr. Williams makes use of the following judicious remarks :—"There is undoubtedly a practical science [art] of discovering mineral deposits and springs. The most skilful prospectors can scarcely explain how they decide upon the place where they dig; and yet, though they are by no means always successful, it is certain that they are more successful than the inexperienced. . . . The practical explorer . . . has a science of his own which affects his mind by the principles of association and memory. He recognises in a new locality the tokens that he has been accustomed to associate with a rich gulch or an abundance of pay-quartz. This practical skill is almost unerring *within narrow limits. Under new conditions it breaks down.*" We could wish that these considerations had come under the notice of Mr. S. Butler before he wrote a passage to prove the inferiority of the mining engineer to such prospectors! But Mr. Williams continues:—"Some of the most absurdly foolish gold-mining enterprises I have ever known have been set on foot by old Californian miners, who, returning to their former homes east of the mountains, have said at once of some ravine or hill-side that it was just the place for gold."

Every close observer will admit, as does the author, that there are many tokens by which the presence of water underground may be inferred. And the hydroscopist is really guided by these signs, and merely fancies that he is obeying the indications of the rod.

The bulk of the work before us consists, however, of a most elaborate account of the metallic ores and other valuable minerals known to exist in the United States. Under "Vanadium" we find the following strange passage:—"Vanadic salts are extremely valuable, and are used principally as a mordant in the manufacture of the finest silks." The chief use of vanadium compounds is in the development of aniline black upon cottons.

The Dynamo: how made and how used. A Book for Amateurs. By S. R. BOTTONE. London: W. Swan Sonnenschein and Co.

THE purport of this book is explained in the title, brief as it is. The author, addressing himself to amateurs, gives exceedingly plain, clear instructions for the manufacture of small dynamos. He has in view the construction of such machines only as can be worked without power, and may "replace a battery of eight or ten cells without the disagreeable concomitants of changing acids and cleaning plates."

Here, of course, there is room for variety of tastes and aptitudes. There are many persons who would find the care and management of a battery far less disagreeable and difficult than the construction of a dynamo, even by the aid of Signor Bottone's able instructions. But for those who have mechanical taste and skill the dynamo will doubtless be preferable.

The illustrations of this work are numerous, well executed, and intelligible.

Notices of a large number of books stand over for lack of space.

In the critique on Dr. Willoughby's "Hygiene: its Principles as applied to Public Health," which appeared in our issue for December last (p. 744), the author is inadvertently represented as pronouncing "lentils the most nutritious as well as the most digestible of all forms of vegetable food." It should have been said "of all kinds of pulse."

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

NEO-PHRENOLOGY, OR HYLO-IDEALISM.

Reverting to my letter in the January number of the "Journal of Science" on the sentient eye being the real source of light, transformed by its magic out of non-luminous tremors, may I be allowed to make the following short further explanation on this point? My position is the result of pure Physical Research, quite innocent of Metaphysics. And yet I am well pleased to be judged by the strictest rules of sound Scotch or German moral philosophy, which quite coincides with Modern Science, in eliminating Ontology, *i.e.*, true Œtiology, or the doctrine of first causes, from the province of human reason and nature. It seems now perfectly irrefragable that the domain of the Absolute is quite unknowable, and that human knowledge is strictly confined to the Relative and empiric sphere. Dr. Brown in his work on "Cause and Effect," Kant in his "Passage from Metaphysics to Physics," and von Hartman, the present dominant authority in Germany, in his "The Unconscious from the Standpoint of Physiology and Darwinism," all tell the same tale. Now I hold that this Phenomenology quite forecloses Theology and all forms of Spiritualism whatever, leaving us face to face with Matter and Force (function) alone. *Nous* or Mind there is in Nature, but it can be nothing else than *our own* mind, and hence all worship of that *Nous* must be Self-Worship. No Brain can ever escape from its own functions. Just as easily may body run away from its own shadow. And in the hylo-ideal sense it is really the Universe, as mirrored in Consciousness, to which we have alone access, so that the *To Pan* is strictly a manufacture of our own mind, *i.e.*, Brain,—all knowledge being thus really a form of cerebral symptomatology. Organ, as has been acutely pointed out to me by the Editor of this Journal, really means *Werk zeng*, *i.e.*, work-generator, and it is hence absurd to postulate force, function, or symptom as antecedent to, or independent of, its generator. This view gets quite rid of Mysticism and Animism, the deadly banes of Science, the two being mutually exclusive, as well shown by Dr. Priestley, *Phlogiston* delusion, which rendered scientific Chemistry impossible. While one shred of ontological occultism vitiates the judgment of its votaries, true empiric Science must ever be heavliy handicapped by Gorgons, Hydras, or Chimeras dire, and can never have free scope for its beneficent mission to humanity.

ROBERT LEWINS, M.D.

GRAVITATION.

IN the "Journal of Science" for November, 1884, a theory of Gravitation is put forth, which is based upon the assumption that there is no universal ether. The attempt at explanation, however, fails, inasmuch as, if even were the postulates granted, the result intended does not become self-evident. Gravitative force is inherent in every particle of matter; and it follows that if we rightly understood the constitution of dense particles we would see that their gravitative forces or tendencies result from their very existence.

It is true that from the time of Newton to the present the problem of reducing the phenomena of gravitation to a simple mechanical conception has completely baffled the greatest scientific intellects. Still a postulate can be given, which if admitted will furnish all that is required, and there may be minds to whom its statement will not be unwelcome.

When we ask the question as to what is necessary to produce the phenomena of gravitation, the answer at once comes that every particle of matter shall virtually be the centre of lines of uniform static tension or pressure,—extremely weak, but universal in extent. If, then, we postulate a universal perfectly elastic ether, and all bodies to be condensed ether originally produced by a compressive force which still continues and maintains the primal concentric strains which produce them, the requisite condition would be reached, and gravitative action would necessarily follow. For every material particle would be the centre of an ethereal stress, the force of which would be in proportion to its mass, and as sensible matter is immeasurably small in amount as compared with the pure ether, the stresses centreing in every body, although universal in extent, would be proportionally weak, and consequently such would be the manifested tractive force. The tendency of bodies to come together would thus really be the tendency to equilibration of the ethereal strains, and which could only be reached by all dense matter coming together and forming one centre of a universal sphere of stress; the only mode of counterbalancing this tendency being the force of tangential motion, such as we see in all cosmic systems. The apparently greater density of the ether within and around dense matter, as deduced from the phenomena of refraction, also favours this view.

Of course this principle of the conservation of matter lies outside the range of physical science, and requires the constant operation of a power above nature; but there is nothing miraculous about it, in the sense of deviation from natural experience. It is intelligible, and offers hindrance to no mode of investigation. I have taken my postulate from the scientific theologian Swedenborg, who claimed that it was revealed to him that the creative energy thus flows into nature, and reaches its quantitative limit in the production of dense and inert bodies, from whence it begins to operate formatively or organically. But other philosophers have held that the conservation of energy is simply the maintenance of the primeval creative force, and that the universe would no longer exist were that force withdrawn.

It should be added that there has been no other mechanical conception of dense matter as *necessitating gravitative action* ever been put forth, even as being maintained by a power above Nature.

WM. DENOVAN.

VARIABLE STARS.

I SHALL be glad if you will allow me to rectify an error in my paper on "Variable Stars. On page 40 you will find that I have stated that the temporary star observed by Tycho Brahé and the star in corona were both situated close to the Milky Way. Clearly enough, if a star is situated in Corona it cannot be nearer the Milky Way than one-half of the Sun's distance therefrom. The mistake occurred as follows:—I had written a paragraph on the Star of 1572, as it appears in the "Journal of Science," and also a paragraph on the Star which appeared in Aquila, A.D. 389, and which was for some time as bright as Venus, eventually disappearing, as others have done, completely. I then continued, as in the article (page 40, line 11 from bottom), "Both these stars, &c."

It struck me afterwards, however, that the instance of the star in corona would be more suitable for purposes of illustration, so I struck out that part relating to the star of 389 in favour of that of 1866, but unfortunately omitted to alter the following paragraph.

On page 34, 13th line from bottom, "analytical" is a printer's error. It should be "analogical."

Readers will greatly oblige by taking note of these corrections, the necessity for which I much regret.

J. R. SUTTON,

NOTES.

We learn with satisfaction that Mr. A. Anthony Nesbit, F.C.S., is about to offer himself as a candidate for the position of Consulting Chemist to the Royal Agricultural Society, vacant by the death of Dr. A. Voelcker. Mr. Nesbit is the son and successor of the late J. C. Nesbit, F.G.S., F.C.S., &c., who up to his premature death was considered the most eminent agricultural chemist in England. Mr. A. A. Nesbit has carried out with success many delicate chemico-physiological researches, for accounts of some of which we may refer to the "Journal of Science (iv., pp. 430, 565, and v., p. 304). Mr. Nesbit has our best wishes for success in his candidature.

At a congress of French learned societies, to be held at the Sorbonne in the course of this year, there will be examined the mode of topographical distribution of each animal species inhabiting the coasts of France; the regions of the French rivers frequented by each species, fish, crustacean, or mollusk, noting the times of arrival and departure, if not stationary, and the time of spawning; the periodic phenomena of vegetation at the epochs of the arrival and departure of birds of passage, at the date of the appearance of the chief species of insects hurtful to agriculture, &c.; the relations between the varieties of zoological or botanical species, and the conditions in which the representatives of each live (altitude, dryness or moisture, &c.).

On October 25th, at 7 a.m., the coldest point in Europe was in the neighbourhood of Paris, where a temperature of $-0{\cdot}5^\circ$ was registered. At Haparanda, near the head of the Gulf of Bothnia, the temperature was $+4{\cdot}5^\circ$, as also at St. Petersburg and Moscow. In the north of Scotland, and over a great part of the North Sea, the thermometer marked upwards of 10°.

Prof. C. V. Riley (American Association) has traced the habits of *Chlænius impunctifrons* from the egg upwards. The eggs are laid singly, in cells made of clay or mud, on the under surface of leaves.

An International Exhibition of Animals is to take place next year at Buda-Pesth.

At Bhosawul, in India ("Ciel et Terre"), there fell in the space of twelve hours, in the night between January 1st and 2nd, 1883, 385 millimetres of rain, or about 15 inches.

MM. L. Hermann and A. von Gendre ("Pflüger's Archiv.") have made experiments on the electromotive properties of hen's eggs during incubation. If an egg is taken out of the incubator, carefully opened, and if conductive points are introduced into the germinal area in such a manner that one touches the body of the embryo, whilst the other is in contact with any point of the yolk, or even of the white of the egg, a current is obtained which passes regularly from the yolk to the embryo, or, in other words, the embryo is positive to the yolk. The electromotive power may amount to 0·01 Daniell. It increases in the first days, at least as far as 80 hours, and then again decreases.

Certain scientific journals are now, so to speak, coquetting with Spiritualism. They will probably soon change sides, eat their own words, and display the usual indiscreet zeal of neophytes.

Mr. G. Makloskie (American Assoc.) shows that the tracheæ of insects have spiral crenulations, which have hitherto been mistaken for threads. The tracheæ transmit gases directly to the tissues without the mediation of the blood. They are not directly controlled by muscles, but their action depends on the successive production of a partial vacuum and on the condensation of the air.

It appears that Mr. W. E. Gladstone has been present at a *séance* with Mr. Eglinton, and has witnessed some successful psychographic experiments! Whether Spiritualism will henceforth take up a political character remains to be seen.

At a late meeting of the Sheffield Medico-Chirurgical Society Mr. C. Atkin exhibited a slug said to have been excreted alive by a young child, which had never received any other nourishment than its mother's milk.

Dr. C. S. Minot (American Association) read a paper on the skin of insects. It consists of three layers,—the cuticle, overlying the epithelium, below which is a sheet of connective tissue. The epithelium is homologous with the epithelium of other animals, and should be so called instead of hypodermis. The connective tissue should be called dermis. The cuticle of caterpillars consists of two layers, a thick and a thin one.

According to M. Urueta ("Union Médicale") cats are great destroyers of venomous serpents in Venezuela. If bitten they do not necessarily succumb.

At the American Association Dr. E. D. Cope read a paper on the Mammalian Affinities of the Saurians of the Permian Epoch.

"Ciel et Terre," in its monthly climatological review, notes that the rainfall has been below the mean in almost every month since January, 1883.

Prof. A. Hyatt (American Association) in a critique on the commonly received views on Heredity, gave the case of a man who resembled his mother on one side of his body, and his father on the other.

The "Kansas Review of Science" gives a long and elaborate argument to prove that the Romans colonised America. The evidence brought forward is merely etymological.

A "Bureau of Scientific Information" is being organised in the United States.

Dr. Chapman, in the "Westminster Review," speaks of the disappearance of birds during an outbreak of cholera as an established fact.

Mr. Cramer (Brooklyn Entomological Society) affirms that twenty-four hours after blowing the larval skin of *Papilio philenor* he has observed the organs of the mouth still moving as in life.

We regret to learn that "M.A. (Oxon)," of "Light," is suffering from the results of a serious accident.

"Light" is responsible for the following:—"I was sitting," said Lord Tennyson, "at Mr. Gladstone's, one side of the table, and Mr. Tyndall was at the other; Mr. Tyndall had been talking of 'God as a notion invented by poets and philosophers';—'Then leave it, Mr. Tyndall,' said Mr. Gladstone, 'to the poets and philosophers, and stick to your science.'"

Dr. Merriam ("Science") denies that the bite of the skunk normally occasions a peculiar kind of hydrophobia, known as *rabies mephitica*. He also controverts the notion that the "spike horn buck" is a distinct variety of the Virginia deer, and shows that they are merely yearling bucks with their first antlers.

"Science" writes that the American National Academy of Sciences is "the only Government organisation now existing, or which ever has existed, the members of which were required to give their services to the Government without charge whenever called upon." Our contemporary is probably not aware that in Britain scientific societies, though not Goverment organisations, are expected to give advice gratis to any Government Department which may need it.

M. G. Pouchet ("Comptes Rendus") has extracted from the evacuations of cholera-patients an extremely poisonous ptomaine. If a trace of this liquid is injected under the skin of a frog, death rapidly ensues, preceded by a remarkable slowness in the motions of the heart, and followed by the most intense rigidity.

M. F. Laur ("Comptes Rendus") calls attention to the coincidence between an earthquake felt at St. Etienne and a sudden fall of the barometer succeeding a time of high pressures.

M. Rochefontaine raises the following question :—If an animal is submitted to a Faradic current over a limited region, under what conditions will a contact with the fingers with some other part of the body produce a commotion in the experimentalist ? The author concludes, from the contradictory results of his experiments, that it would be imprudent to found upon phenomena of this kind a method of distinguishing real from apparent death.

According to M. Forgola (" Ciel et Terre") observations made continuously during the last twenty-five years, at the Observatory of Pulkowa, present discrepancies explainable on the supposition of a progressive decrease of latitude at the rate of about 1″ per century.

According to " Cosmos les Mondes " a personage occupying an eminent post in French diplomacy has written to an astronomical paper to ask " what planet had passed between the Earth and the Moon, so as to cause the recent total eclipse ?"

It is significant that in the journal above quoted we find fourteen pages out of a total of forty-seven devoted to the art of war. What say the Peace Societies ?

A writer in the " Truth Seeker " asserts that, so lately as five years ago, a woman was burnt to death in the province of Novgorod for alleged witchcraft.

B. Tacke (" Bericht. Deutsch. Chem. Gesell.") finds that, in the rabbit, considerable quantities of combustible gases are eliminated from the organism through the blood and the lungs. The quantity expelled *per anum* is much smaller.

A new metallic element is announced, by Prof. Welsky, under the name of Idunium. It occurs in native lead vanadiate.

M. G. Desrameaux has obtained a patent for a machine which, in a minute, can produce an absolute vacuum in a receiver of the capacity of 2000 litres.

M. le Goarant de Tromelin maintains that the mean temperature of the Northern Hemisphere is decreasing, whilst that of the Southern is increasing.

The author of " Ceylon, Ancient and Modern " has, at " Twickenham : printed by and for the Proprietor (privately), 1884," a comical little volume under the pronounced title " Anti-Darwin, or some Reasons for not accepting his Hypothesis. It opens thus :—

> " Poor race of men says the sceptical spirit,
> A fig for your ' primal fall.'
> Some graces ye may inherit,
> But the trace of the ape is over them all."

At the November meeting of the Royal Microscopical Society an improved form of Gas Microscope was exhibited by the inventor, Mr. Lewis Wright. The performance greatly surpassed in definition and rendering of colour anything that has hitherto been produced. In addition to objects specially prepared by Mr. Topping, several selected by Dr. Carpenter were handed to the exhibitor and successfully projected on the screen. The objective which has worked best is one of 8-10ths of an inch, made with larger glasses than is usual for microscopic purposes, and corrected solely for the purpose of projecting objects upon a screen. The field is flat, and the definition good to the circumference of the disc. No doubt still greater improvements will be effected, as the inventor has worked upon a new principle. Hitherto ordinary objectives have been employed, but although they give good images in the comparatively small fields used in photo-micrography, they are generally deficient in light and definition when very great amplification is attempted. The present advance will prove of immense value to lecturers in the demonstration of histological subjects, as exhibitions on the screen have been confined to photo-micrographs enlarged by a superior magic-lantern.

After a late tempest, about five hundred dead crows were found on the Norwegian coast, near Bergen. It is supposed that the birds had been at roost on the small rocky holms and had been suddenly overwhelmed by the storm. This is a comment on the notion that the lower animals have an instinctive foreknowledge of the weather.

Mr. E. T. Nelson, in "Science," gives an account of a pumpkin, freshly gathered and perfectly sound, which, when cut open, was found to contain seeds which had already germinated. The caulicles were from one to three inches in length, while some of the rootlets were over seven inches. The cotyledons, wherever free from the seed-covering, were green in colour, and spread so as to expose the growing plumule. In one case the second leaves were partly unfolded.

M. Chairy ("Comptes Rendus") concludes, after a long series of experiments, that the medium in which bacteria live has only a slight influence on the proportion of poison necessary to prevent their development or to destroy the spores. The mass of the bacteria existing in the medium has a marked influence. Chemical agents act the more energetically the more acid their character, which may perhaps be deduced from the fact that bacteria tend to render their medium alkaline.

According to G. Lindström a scorpion found in the Upper Silurian of the island of Gothland is the most ancient terrestrial animal yet discovered. Its four pairs of thoracic feet are pointed like those of the embryos of many other Tracheata and of animals such as Campodea. This form of feet does not occur in the fossil scorpions of the Carboniferous ages.

Sir Spencer St. John, who, having been for many years British Consul in Hispaniola, has enjoyed extensive opportunities for observation, finds that though up to the age of puberty the negro is mentally equal to the white, after that time he falls hopelessly into the background.

The mortality among chemists continues. Angus Smith, Kolbe, Voelcker, Wigner, and Vierordt have followed Dumas, Würtz, and Thenard.

An unknown writer, from Fiji, remarks that when flocks of terns and other sea-fowl rest upon the sea in great numbers the water becomes smooth, and there is "not a ripple to disturb them." This the writer ascribes to oil emitted by the birds.

At the Ischia earthquake there occurred a very decided case of "scare-cure." A woman who had been bed-ridden for months jumped up, saved herself by flight, and remained permanently cured.

According to M. Delaunay, robust children cross the right leg over the left earlier than do weaker ones.

M. de Varigny ("Revue Scientifique") denies, on the faith of careful experiments, that scorpions, if surrounded by fire, sting themselves to death.

A writer in "Les Mondes" revives the view that atmospheric ozone is antagonistic to epidemics.

An iceberg has been found in Davis's Straits, which must have floated from the mouth of the Lena, as it contained relics from the unfortunate *Jeannette*. It is conjectured that it must have traversed seas near the North Pole.

"Science" asserts that a considerable portion of the American people still believe in witchcraft, and that "our school system, with its imperfect scientific training, makes no efficient battle against these pernicious relics of the past."

Dr. Szpilmann ("Berichte Deut. Chem. Gesellschaft") finds that air, and still more pure oxygen, promotes the multiplication both of the bacilli of anthrax and those of putrefaction. Ozone, on the other hand, is fatal to the latter, but has no injurious action upon the former.

Dr. Glaser concludes that heavy winter rains and floods are very destructive to insect life.

Communications on the migrations, dates of nesting, &c., of birds may be addressed to Herr G. von Hayck, at Vienna (Secretary of the International Ornithological Congress).

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I. THE HEAT OF THE SUN.

By Ernest H. Cook, B.Sc. (Lond.), A.R.C.S., F.C.S.

WHEN we consider the magnificence and beauty which, under favourable conditions of the atmosphere, the heavenly bodies exhibit, it is a matter of no surprise that the most brilliant and grandest of them all should have attracted and rivetted the attention of the earliest philosophers. Accordingly we find in the very first pages of the world's written history, under the influence of an Eastern Sun, that those Chaldean shepherd astronomers speculated as to the constitution and position of the central luminary. Long before the enormous distance of the Sun was approximately fixed, speculation began to be made to attempt to account for the source of the enormous amount of heat which is given out by the Sun. The first and most unscientific of these theories of the source of the Sun's heat (that of combustion) was propounded before any actual experiments had been made as to the exact amount of heat which is constantly given out. Thus attempting to explain and account for something which was not known, it is not to be wondered at that subsequent discovery and investigation have shown the utter inadequateness of this first assigned cause of the Sun's heat. Before we state and examine the various theories it is necessary for us to thoroughly understand and appreciate the vastness of the action we have to account for.

The distance which separates us from the Sun has been determined with very great accuracy, because of its importance to astronomers, this distance forming their unit of length. With tolerable accuracy we may take this as equal to 92,000,000 of miles. Although this distance is infinitely small when compared with the distances of many of the stars which are familiar to astronomers, it is yet so great compared with our ideas of distance that we can form no conception, however remote, of it. Fortunately, however, we are now dealing not with conceptions and imaginings, but with bare and unvarnished facts. Knowing this distance, knowing also the apparent magnitude,—*i.e.*, the observed diameter of the Sun,—it is easy to calculate his real diameter. This has been found to be approximately given by 880,000 miles. These distances being determined, and the fact established that the planets revolve round the Sun, it follows that there must be some force pulling these planets, emanating from the Sun, which causes them to revolve around it. This force we know to be that of gravitation. Again, the period which it takes for the Earth to revolve around the Sun is given by the length of what is called a mean solar year. It is also known that the length of this mean solar year has not altered during the period of recorded astronomical observation. It therefore follows that the force pulling the Earth, and keeping it in its orbit, is just sufficient to do so and no more. For if the Sun's force acting upon the Earth were more than just sufficient to do this, the year would be gradually diminishing in length by an amount which would be proportionate to this excess of force. In short, the Earth would be gradually approaching the Sun. If, on the contrary, the force were less than just sufficient to do this, the year would be gradually increasing in length : in short, we should be receding from the Sun. Observations extending over a great number of years prove that neither of these things is occurring. Now if we know the mass of a body which is moving in a certain orbit, if we know the radius of that orbit, and also the velocity with which the body is moving, we can find, by employing a formula well known to scientific men, the force which is emanating from the centre, and which is just able to keep the body from moving out of that orbit. Calculating in this manner, it has been deduced that the attraction which the Sun exerts upon our globe is equal to that which would be exerted supposing it to consist of 360,000 earths rolled into one. Now we have just seen that the diameter of the Sun is 880,000 miles ; that of the Earth is 8000 ; thus the Sun's diameter is about 110 times greater. The bulk or cubic capacity of the Sun is therefore the cube of 110, or 1,331,000 times that of the Earth. But the mass, calculated from the attraction which it exerts, is only 360,000 times greater, —consequently the materials of which the Sun is composed must be much lighter than those which compose our Earth. Speaking accurately and scientifically we should say that if the density of the Earth be taken as unity, that of the Sun is only 0·250; or if, as experiment shows, the mean specific gravity of the Earth is equal to 5·2, then that of the Sun is equal to 1·3.

Having now fixed some of the physical constants of the centre of our planetary system, we have to determine the amount of heat which is given out. In the first place, it is evident that we who live upon the Earth must necessarily make our observations upon the Earth; it is thus important that we should know what fraction of the total amount of heat emitted by the Sun is absorbed by the Earth. The radius of the Earth's orbit, we have already seen, may be taken as 92,000,000 miles; the circumference of the approximate circle which is described around the Sun is thus equal to 3·1416 × 92,000,000 × 2, or about 578,000,000 miles. The diameter of the Earth is about 8000 miles; consequently the Earth occupies about the 73,000th part of the circumference of the approximate circle which it describes around the Sun. But this refers only to one plane. Taking the area of the hollow shell surrounding the Sun at a distance of 92,000,000 miles as equal to 115,000,000,000,000,000 square miles, and taking the Earth as a flat plane 8000 miles in diameter, or 50,000,000 square miles in area, we find that the Earth intercepts the 2,300,000,000th part of the total heat emitted by the Sun. If, then, we find the quantity of heat received by the Earth, and multiply it by this last number, we shall obtain the actual heat given out by the Sun.

By allowing the rays from the Sun to fall perpendicularly upon a surface which is capable of absorbing them, and warming a known quantity of mercury, the heating power of the Sun has been determined. Two series of observations on this point have been made: one at Paris by M. Pouillet, with his pyrheliometer; and the other at the Cape of Good Hope by Sir John Herschell, with his actinometer. The results are concordant, and they give that the amount of heat received by the Earth in one year would be capable of liquefying a layer of ice entirely surrounding the Earth to a depth of 100 feet. This, then, is the amount of heat which falls upon an area of 50,000,000 square miles; multiplying this by 2,300,000,000 we obtain the total amount of heat emitted by the sun. In speaking of the distance of the Sun it was stated that we could form no idea of the vastness of the distance which separated us from him. And, if it is impossible to form an idea of the distance, it is also equally impossible to form an idea of the immense heat which he possesses. The highest temperatures which we can obtain are so cold compared to his temperature that the comparison between an Arctic winter and an Equatorial summer is quite inadequate to represent the difference. Thus Prof. Tyndall says—"The heat emitted by the Sun, if used to melt a stratum of ice applied to the Sun's surface, would liquefy it at the rate of 2400 feet an hour. It would boil per hour 700,000 millions of cubic miles of ice-cold water."

Another eminent writer upon this subject, Sir John Herschell, says "that the heat thrown out from *every square yard of the Sun's surface* is equal to that which would be produced by burning on that square yard 6 tons of coal per hour, and keeping up constantly to that rate of consumption. And this, mind, on each individual square yard of that enormous surface which is 12,000 times that of the whole surface of the Earth."

In attempting to bring the imagination to grasp such enormous numbers and statements we are attempting a hopeless task; it recoils from such immensity much as a billiard ball recoils from the cushion upon which it strikes. But although thus unable to appreciate such facts the reasoning powers of many (I may perhaps say most) scientific men have been employed from time to time for the purpose of seeking a *cause* which shall be a sufficient and a possible one to account for this enormous expenditure of power,—an expenditure, be it remembered, which has been going on, at least during historic times, without the slightest diminution.

The theories which have been proposed from time to time we will now examine, taking them in the order of their age, and impartially examining each.

The Combustion Theory.

This is the oldest, simplest, and most unscientific of the whole. It cannot be ascribed to any author, and in fact it is probable that most thinkers upon the subject, upon a first and superficial examination, would propound such an explanation. Shortly expressed it says that the Sun is a fire, differing only from our terrestrial fires in magnitude and in the intensity of its combustion. Now as the substance which we use most extensively, and which gives us more heat than any other common substance, is carbon, consequently it has been suggested that the Sun consists of a mass of carbon in an active state of combustion. This, then, is the first crude idea which was held respecting the constitution of the Sun. Before we allow ourselves to wonder at the authors for proposing so unsatisfactory an explanation, we must bear in mind the "nature of the environment," if I may so call it, in which they were placed. In the first place the distance of the Sun was not thought so immense as it is now proved to be; secondly, the age of the Earth was not considered so great as at present,—consequently a less powerful cause had to be found; and thirdly, those wonderful discoveries of the spectroscope which have revealed to us the physical construction of the Sun had not been made.

Now in order that combustion, as we term it, should go on, there must be some substance with which the combustible body can combine. Here on our Earth this body is known to be oxygen, and it is supposed that the same body exists in the Sun, and by its combination with the carbon produces the heat which we find given out. Again, we know that 1 lb. of pure carbon, in burning so as to produce the greatest amount of heat, combines with $2\frac{2}{3}$ lbs. of oxygen. Also one cubic mile of pure oxygen will weigh about 13,189,120,000 lbs. Now on every square yard of the Sun's surface there is given out as much heat as would be produced by the burning of 6 tons of carbon per hour: 6 tons of carbon will require 35,840 lbs. of oxygen, and such an amount of oxygen would be contained in a column 1 square yard base and 14,336 yards high. Thus in every hour the Sun uses up a column of pure oxygen 8·3 miles high, and of the density of the gas at the average atmospheric pressure here on the Earth. But the attraction of the Sun upon any body placed near it is, in consequence of its mass, very nearly thirty times as great as the attraction of the Earth upon the same body. We will thus reduce the height of this column this number of times, and thus obtain that every hour there is used up a shell of about 3-10ths of a mile thick around the Sun of pure oxygen. (This difference in attractive power is only mentioned to guard against misrepresentation, and for the purpose of making the latter part of the argument more conclusive.) The immense heat of the Sun would expand gaseous bodies so much as to counterbalance the effect of the increase of gravitation. Moreover, as we recede from the Sun the attractive force diminishes, according to the well-known law of the square of the distance, and therefore the density of the imaginary atmosphere also decreases. But if this is the amount used up in one hour it is easy to calculate the amount used up in any number of hours or years. We thus find that in five thousand years the height of the atmosphere of pure oxygen consumed would be 13,240,000 miles high, *assuming* the density the same as that which it would have at the *surface of the Sun.* If, however, we consider, since pure oxygen is a most unlikely substance to exist in such quantity, that the solar atmosphere consists of the same materials as the terrestrial one, in fact that it is only part of the universal atmosphere,—an assumption which has been made, and which is highly probable,—then the height of the atmosphere required for a period of five thousand years becomes 66,200,000 miles. This distance is much greater than the distance of the planet Mercury, and is about equal to that of Venus, from the Sun.

We therefore see that, examining the theory in this way (which the author believes to be a novel one), we are called upon to assume the existence of a solar atmosphere extending up to the planet Venus, and possessing a density thirty times as great as that of the Earth at the sea-level. And this immense volume is required for the comparatively short period of five thousand years. Taking Croll's estimate of the age of the Earth as 20,000,000 of years, we must extend the atmosphere about a hundred times as far as the orbit in which the most remote member of the planetary system revolves. It is needless to say that such a state of things is impossible, for the retardation which the planets would suffer would most assuredly have been discovered long before this, and it is probable that owing to such retardation one or more of them would have fallen into the Sun.

I have selected this method of viewing the combustion theory because the conclusions drawn from it are so obviously impossible. It can, however, easily be shown that, at the rate of burning necessary, a block of pure carbon of the size of the sun would be burnt out in about five thousand years. We can also ask, What becomes of the products of combustion? Where is the carbonic anhydride stored away? These and other questions impossible to answer compel us to at once put aside the combustion theory as not only untenable, but impossible.

Many modifications (if we may so call them) of this theory have been proposed, but they all fail to afford an adequate cause. Thus the suggestion has been made that the oxygen needed for combustion may be supplied from the material of the Sun itself, just as gunpowder is supplied with oxygen from the nitre it contains. But even supposing him to consist of gun-cotton, the substance which is better supplied with oxygen than any other, it is easily calculated that he would be burnt out, and

> . . . . "wander darkling in th' eternal space,
> Rayless and pathless,"

in less than eight thousand years.

These various suggestions—for we cannot call them theories—we will not stop to consider. Ingenious and yet simple, as many of them are, they one and all fail to rise to the magnitudes with which they have to deal. We pass on to the consideration of the next, and certainly one held by many physicists.

The Meteoric Theory.

Born in the little town of Heilbronn, Würtemberg, the illustrious originator of this theory would have lived and died a respected German physician had he not possessed a strong mental bias in favour of physical speculations. In such a case the strong influence which his writings have made upon the thought of the present day would have been wanting, and the world would have been ignorant of the name of Robert Julius Mayer. But here we must guard ourselves against falling into the opposite extreme, and giving all the credit to one. I have called Mayer the *originator* of the theory, and so in truth he was, having published his "Essay on Celestial Dynamics" in 1848. But, as is generally the case, other minds were at the same time actively engaged upon a similar subject. It was not, however, until the Hull Meeting of the British Association, in 1853, that Waterton sketched the same theory, being at the time quite ignorant of Mayer's previous writings. Waterton's paper attracted the attention of the celebrated mathematician and physicist, Sir William Thompson, and in a beautiful memoir—published in the "Transactions of the Royal Society of Edinburgh" for 1854—the whole theory is exhaustively worked out and developed. With the help of these writings we will now endeavour to give, as briefly as possible, an outline of this interesting theory.

It is necessary, however, to a proper appreciation of the subject to acquire a little preliminary knowledge. Suppose a body to be moving and we stop that body's motion, we know that we have to exert force to do so. Moreover, the heavier the body the greater force is required, or, with the same weight, the faster it goes the more force is required. Given the weight and the velocity of motion, we can calculate the work required to be done to bring the body to rest. Again, it has been proved that work or energy and heat are mutually convertible,—*i.e.*, that a certain amount of heat can be produced by the expenditure of a certain amount of work, and also that a certain amount of work will heat a given body to a certain degree. This has been called the Mechanical Equivalent of Heat, and we may state it thus:—If the work required to raise 1390 lbs. one foot high be done upon 1 lb. of water, the temperature of that water will be raised 1° C. Now, as was said above, we can calculate the amount of work which must be done in order to stop the motion of a moving body, and therefore, if this work be transformed into heat, we can find how much the temperature of the body will be increased. Thus we find that the heat given out by stopping the motion of a leaden bullet moving at the rate of 1300 feet a second would raise its temperature about 600° C., if all the heat were retained by the bullet.

To the imagination it is an easy matter to rise from the consideration of the impact of a rifle bullet to consider the impact of worlds. In effect this is what the Meteoric Theory does, only instead of worlds it considers the collision to occur between the Sun and meteors and comets. In our solar system there exists a numerous class of small bodies called asteroids. These small bodies, like the larger ones, are subjected to the law of gravitation, and are attracted by the Sun. Any medium which exists in space, however rare it may be, would exert a comparatively greater action upon small bodies than upon large ones, such as the planets.* Thus, although these latter may not have their motions affected, the former may be rapidly caused to approach the Sun. It is thus supposed that the Sun is constantly subject to a cannonade of small bodies upon its surface. But if such a rain of these small bodies is constantly falling from the outermost limits of our system upon the Sun, it is evident that as they approach near him they become condensed. We ought therefore to be enabled to see such a crowd of meteors before they fall into the Sun. This is supposed to be proved by the existence of the mass of hazy matter which surrounds the Sun, known as the Zodiacal Light. Whether or not this consists of an assemblage of meteors it is, of course, impossible to say; but the matter composing it has been shown to obey the ordinary laws of planetary rotation, and thus to behave exactly as meteors would.

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* It is interesting to note here that the idea of the universal existence of the atmosphere is introduced in the Meteoric Theory.

There are two ways in which a body may fall into the Sun: it may fall directly upon it, or it may revolve around it in gradually diminishing orbits until it is at last absorbed. The final velocity which it would have is very different in the two cases; in the first, supposing it to fall from an infinite distance, it would have the greatest velocity possible, *viz.*, 390 miles a second. In the second case, where the velocity may be supposed a minimum, it would be equal to 276 miles a second. Striking the Sun with its maximum velocity, the body would generate "more than 9000 times the heat generated by the combustion of an equal" amount of coal. Striking with its minimum velocity, it would produce 4000 times as much heat.

"Here, then, we have an agency competent to restore his lost energy to the Sun, and to maintain a temperature which far transcends all terrestrial combustion. . . . It may be contended that this showering down of matter necessitates the growth of the Sun: it does so, but the quantity necessary to maintain the observed calorific emission for four thousand years would defeat the scrutiny of our best instruments."—(Tyndall.)

The amount of heat generated by the fall of these meteors is thus undoubtedly sufficient to produce the temperature we find, and there also can be no doubt as to the number of these bodies existing in the Solar System. When we remember the large number of meteors which are seen by observers, also that the vast majority can only be seen at night, and the small bulk which the Earth occupies in space, we cannot but admit the sufficiency of the cause in regard to quantity. Thus during one observation at Boston there were observed, in nine hours, no less than 240,000 meteors; and thus in a year we may conclude that hundreds, perhaps thousands, of millions fall into the Earth's atmosphere.

Sir William Thompson, in developing this theory in the paper before mentioned, has modified it somewhat. His first idea was similar to that of Mayer, that the meteoric matter raining down on the Sun circulated close to him. But if there be this matter existing round the Sun, it is difficult to account for the fact that comets are observed to pass quite close to him, and therefore through this matter, without suffering any loss of energy. Thompson has therefore come to the conclusion that the heat of the Sun was *produced* in this way, but is not thus *maintained*. He considers "the low rate of cooling, and consequent constancy of the emission, is due to the high specific heat of the materials of which the Sun is composed."—(Tyndall.) Thus in effect the Sun is cooling down; but at the enormous rate at which he gives out heat, according to our knowledge of terrestrial things, we should imagine he would soon be burnt out. But this notion, if it exists, must be dispelled, as Thompson proves that the heat thus originally produced is able to supply the Sun with sufficient to last him for no less than 20,000,000 years.

But although dealing with small masses of matter, this theory is not confined to them. The heat may be produced by larger masses striking the Sun. In the history of astronomical observations we have it set down that occasionally stars are observed to suddenly increase in brilliancy until they reach a maximum, and then to decline until they reach their former brightness. Thus in 1572 an entirely new star suddenly "appeared in the constellation Cassiopeia, and gradually increased in brilliancy until it surpassed all the other stars. It could be plainly seen in the daytime. On a sudden, November 11th, it was as bright as Venus at her brightest. In the following March it was of the first magnitude. It exhibited various hues of colour in a few months, and disappeared in March, 1574."—(Draper.) Since then many similar occurrences have been noted. These can only be satisfactorily explained by supposing a collision between two bodies to have occurred. Acting upon this idea Sir W. Thomson has calculated the heat which would be given out by the various bodies composing the planetary system falling into the Sun. The table is as follows, the heat being expressed as able to sustain the solar emission for the stated times:—

Mercury	6	years	214	days.
Venus	83	,,	227	,,
Earth	94	,,	303	,,
Mars	12	,,	252	,,
Jupiter...	32·240	,,		
Saturn	9659	,,		
Uranus	1610	,,		
Neptune	1890	,,		

Thus if the Earth were to fall into the Sun the heat which would be given out by the sudden stoppage of the motion would be sufficient to keep up the present rate of solar emission for a period of 94 years 303 days. In addition to the amounts given in the Table there must be added the heat which would be produced by the stoppage of the rotation of the planet on its axis, which in the case of the Earth would supply the Sun for 81 days. "The heat of rotation of the Sun and planets, taken together, would cover the solar emission for 134 years, while the total heat of gravitation (that produced by the planets falling into the Sun) would cover the emission for 45,589 years."—(Tyndall.)

In the foregoing sketch of a theory which has influenced so mightily the progress of solar physics, I have endeavoured to confine myself as much as possible to the words of its authors and supporters. In taking a survey of it in its entirety we cannot but be struck by the really beautiful way in which everything is derived from one original and all-pervading law—that of gravitation.

Given the existence of matter and the law of gravitation, the theory shows how the universe may have been produced. The same force which causes the apple to fall to the ground, acting through distant ages, gave us the light and heat of the Sun which caused the apple to ascend on the tree. Unity and design pervades the whole, and this is what we find everywhere in Nature.

Again, throughout the whole of the theory there is no assumption of either hypothetical substances or hypothetical forces; no luminiferous ether with its Protean properties, the single blot on the Undulatory Theory of Light; no attractive and repulsive zones, as in the Corpuscular Theory. Starting with matter as we find it on the Earth, it works out its results according to the operations of known and thoroughly established laws. This is an important point, for the theory was propounded and worked out long before Kirchhoff had given to the world his immortal discovery of the existence of terrestrial matter in the Sun. Subsequent discovery proves that the universe contains no matter not existing on the Earth, and the Meteoric Theory calls for no other.

What I may call the essential elements of a theory are therefore here present; its ultimate fate must therefore depend upon some more probable explanation being proposed. We rightly consider the prediction of a hitherto unknown phenomenon, which is afterwards proved to be true, as a triumph of theory. Thus the discovery of Neptune and that of Conical Refraction are considered as having fixed the Gravitation and Undulatory Theories respectively on a firm basis. It happens that the Meteoric Theory has also its prediction. Owing, however, to its nature we are and shall be unfortunately unable to verify it. The prediction is nothing more nor less than that of the end of our planetary system, and in fact of the universe. Moons will fall into planets, planets into suns, and suns into other suns, and at the last only one mighty sun will remain. This is the end to which all must come.

In taking leave of this theory I cannot omit to mention one important point which I do not think has been raised before, and which, so far as I am aware, has not attracted the notice of its supporters. It will be seen that one of its assumptions is that the central body is gradually, although very slowly, attracting the revolving bodies nearer to itself. Extending this idea very slightly, we have that the planets acting as central bodies ought to be gradually attracting their satellites. This point has been fully and ably worked out by Mr. G. H. Darwin, and he has come to the conclusion that the Moon has been, and still is, gradually receding from the Earth. Upon this point, therefore, theory and observation seem to be opposed to each other, and we shall be glad to see the explanation of the supporters upon it.

The Contraction Theory.

In the above statement of the Meteoric Theory it is pointed out how comparatively small an addition to the bulk of the Sun is able to support the loss of energy which he suffers. But although undoubtedly the amount which has fallen during historic times is small compared to the immense bulk of the Sun, yet when we consider geologic times the case is different. The additions which the Sun has received during these times must have caused a great change in the periods of planetary revolution; and it is hardly possible to avoid the conclusion that, if such is taking place, some evidence of it would have been found ere this. Considerations somewhat of this nature induced the great German philosopher Helmholtz to discard the theory, and to propose in its stead one founded on the heat given out by the contracting of the body of the Sun, and hence called the Contraction Theory. Speaking of this theory in a recent lecture at New York, Prof. Young, of Vermont, says:— "It is the one held by most scientific men, and is one which I think will be found more than half true." Without entirely endorsing Prof. Young's words, there can be no doubt that we have in it a thoroughly competent cause to produce the effects.

Starting at the beginning, Helmholtz assumes the truth of Laplace's great conception known as the Nebular Hypothesis. This theory supposes, as is well known, that at one time—millions of years ago—the whole of the matter composing the various members of the solar system, together with any interplanetary substance which may exist, was diffused in space in the form of highly rarefied gas. The only known cause capable of keeping such materials in such a condition is heat, and it is thus further assumed that the whole of the heat in our system, together with a large quantity which has been wasted in space (*i.e.*, space beyond the confines of the orbit of Neptune), was stored up in the nebulous matter in the form of latent heat. This highly rarefied matter gradually radiated its heat into space, and in consequence began to diminish in bulk, and at the same time to increase in specific gravity. Planets and satellites began to form out of it, and the process of cooling and contraction continued until the system assumed its present condition. In this process, assuming the specific heat of the condensing matter to be equal to that of water, Helmholtz calculates that the heat given out would raise the temperature 28,000,000° Centigrade. What, then, has become of this immense amount of heat? All of it, except a very small fraction, has been radiated into stellar space, and lost amid the vast recesses which practically exist between suns or between the satellites of suns. The small fraction has been intercepted by the matter of some of the planetary bodies, and its energy, or some portion of it, used up in rearranging the materials of the planet. In this way, perhaps, the vast store of energy which the deposits of carbonaceous matter in the Earth possess, may have been derived from the condensation of the nebulous matter, and was employed at one time in keeping the molecules of that substance in a state of vibration. But the process of condensation having gone on from the remotest times up to the present does not stop here. Helmholtz supposes it to be still going on, and in this way he accounts for the heat which we and our fellow-worlds derive from the Sun. According to this theory the central orb is radiating heat into space at the enormous rate indicated at the commencement of this paper, and is being cooled by the loss thus experienced. In consequence of this cooling the materials composing the Sun must occupy less space, and consequently its diameter become less.

Moreover, the more rapid the shrinkage the greater the amount of heat radiated; or, in other words, knowing the amount of radiation taking place, the weight and volume of the radiating body, and its specific heat, it is possible to calculate the rate of shrinkage necessary to keep up the energy expended. Without going farther the superficial reader would at once discard the theory as untenable. "Here," he would say, "you have the Sun emitting radiant energy at this enormous rate, which has demonstrably not diminished during historic times, and has probably continued for 20,000,000 years; and all produced by the shrinkage of his substance. Why long ere this he would have shrunk into a cold dead mass." But let no one imagine the celebrated German guilty of want of care in examining the subject. He has made the calculation indicated above, and he proves that a shrinking of the Sun's diameter by 1-10,000th of its present length (*i.e.*, 88 miles) would produce an amount of energy capable of keeping up the solar emission at the present rate for two thousand years. But if the Sun be supposed to go on contracting, and its specific gravity to go on increasing until it equals that of our Earth, then Helmholtz shows that the heat evolved would supply the Sun with energy for no less than 17,000,000 years!

In brief outline this is the celebrated theory of Contraction. Simple in its assumptions, and quite competent to fulfil the demands made upon it, it is not a matter of surprise that it is held by many of the first thinkers of our time. Yet we cannot help thinking that two considerations weigh heavily against it. First, the researches of modern spectroscopy seem to indicate that we have in the Sun an intensely hot nucleus, surrounded by an atmosphere or shell of less intensely heated matter. Now if the heat is produced by condensation the whole body would be equally heated, and consequently no such partial separation would take place. Also the formation of a nucleus is difficult of explanation on such a theory, for although the *temperature* of the nucleus may be greater, the *actual heat* in the solar atmosphere must be greater. Secondly, as Siemens has pointed out, the heat being produced throughout the mass must reach the surface by conduction and convection. But we know of no substance capable of conducting the immense amount of heat which we find being radiated.

The Regenerative Theory.

This theory, which I have so named because of its most characteristic feature, is at present literally and absolutely in its infancy, It first saw the light in March, 1882, having been proposed in a paper entitled the "Conservation of Solar Energy," read before the Royal Society of London by the late Sir C. W. Siemens, F.R.S., the President of the British Association for 1882-83. It essentially differs from all the other theories in that it supposes the action of the Sun, in sending out light and heat, to be "capable of prolonging solar energy to the remotest future."* But if it is to last for such a time, it is a physical necessity that very little of anything should be used up or expended. Accordingly the action is maintained by the energy being conserved and protected from loss. This is accomplished by supposing reciprocal actions to go on using only the same materials, but under different conditions. The different conditions are those which obtain in or near the Sun, and those of interplanetary space. In the one case we have intense heat, and in the other equally intense cold; and I may here remark that it would be impossible to conceive of matter being placed in positions which afford conditions possessing greater contrast. Matter is supposed to be subjected, at different times, to these different conditions, and its behaviour under such conditions produces in the one case the heat and light of the sun, and in the other the materials necessary for maintaining this heat and light. Without further preface we will state Dr. Siemens's theory in as nearly as possible his own words.

After briefly stating the various theories, and offering certain objections to them, he says—"The true solution of the problem will be furnished by a theory, according to which the radiant energy which is now supposed to be dissipated into space, and irrecoverably lost to our solar system, could be arrested and brought back in another form to the Sun itself, there to continue the work of solar radiation." After this preliminary assertion he proceeds to state the fundamental assumption that all space is filled with highly rarefied gaseous bodies, including hydrogen, oxygen, nitrogen, carbon compounds, &c. The planetary bodies scattered in such an atmosphere would attract to themselves atmospheres varying in density according to the varying density of the planet. But this attraction would be to a certain extent selective, and consequently such atmospheres would consist of the heavier, and therefore less diffusible, gases, while the lighter would remain in space. In space, therefore, there would be a vast preponderance of hydrogen and the lighter hydrocarbons. But, again, the planetary system as a whole will attract the rarefied gases existing in stellar space ; thus we shall have existing in space what may be called three classes of atmospheres,—inter-stellar, inter-planetary, and planetary. Each of these will vary in density, the first according to the distances of the stars, the second according to the mass of the particular system as a whole, the third according to the mass of the attracting planet. In support of this view the molecular theory of gases is brought in,—the evidence afforded by the analyses of gases occluded by meteorolites which have fallen upon the Earth, and the teachings of spectrum analysis. Each of these is in itself a perfectly sound and practically unanswerable argument in favour of the existence of a universal atmosphere.

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* These are the concluding words of the first paper on the subject which was communicated to the Royal Society. In a letter to the present writer, however, Dr. Siemens states that he does not mean by this that his theory provides anything in the way of perpetual motion, but only that he considers it "capable of continuing solar radiation to a very remote future."

In regard to the idea that if such atmospheres did exist the central body of each system would attract to itself the heavier gases, whereas the revelations of spectrum analysis show a prevalence of hydrogen, Dr. Siemens remarks that it can be shown that at such a temperature as the Sun possesses no carbon dioxide or carbon monoxide could exist, and in fact supposes, with Lockyer, that the metalloids can also have no existence. But he says that outside the photosphere there must be regions where these gases would accumulate "were it not for a certain counterbalancing action." This counterbalancing action is provided for by the high rotative velocity of the Sun, which is equal to about 1·25 miles a second at the Sun's equator, or nearly 4½ times that of the Earth. Such a movement must cause an equatorial rise of the solar atmosphere. La Place has, however, calculated that owing to this cause the height of the solar equatorial atmosphere could not possibly exceed 9-20ths of the distance of Mercury. His calculation is, however, vitiated by his assumption of the emptiness of stellar space. If we suppose this action to go on in a medium, then a fan-like effect is exercised upon that medium, resulting in a movement outwards at the Equator and a drawing in towards the Poles. The Sun therefore, upon this hypothesis, is supposed to have around his Equator a disc of matter rapidly leaving him, and at the Poles matter approaching him. In this way, Dr. Siemens says, enormous quantities of "hydrogen, hydrocarbons, and oxygen are supposed to be drawn towards the polar surfaces of the Sun." "During their gradual approach they will pass from their condition of extreme attenuation and extreme cold to that of compression, accompanied with rise of temperature, until on approaching the photosphere they burst into flame, giving rise to a great development of heat, and a temperature commensurate with their point of dissociation at the solar density. The result of their combustion will be aqueous vapour and carbonic anhydride or oxide, according to the sufficiency or insufficiency of oxygen present." These products of combustion will come under the influence of centrifugal force, and move towards the Equator, where they will be projected into space. As they recede from the Sun they gradually lose their heat, and become more and more rarefied, until they obtain the extreme state of rarefaction which they possess in inter-planetary space. Here it is supposed the inverse action to that which occurs in the Sun takes place. The now highly rarefied aqueous vapour and carbonic anhydride absorb some of the radiations which the Sun is constantly pouring out, and it is supposed that at the extremely low pressure to which they are subjected they are dissociated, oxygen, hydrogen, and hydrocarbons being produced. These are in turn again drawn in to the polar surfaces by the fan-like action produced by the solar rotation. Thus we see that a continuous circulation of matter occurs, the same element alternately forming a portion of the coldest portion of inter-planetary space, and the hottest portion of the central luminary.

Such in outline are the chief points of this latest theory of solar action. There are some other secondary points which are rendered necessary in consequence of the known constitution of the Sun. For example, we know that the solar atmosphere contains large quantities of the vapour of certain metallic bodies. These are supposed to constitute an inner atmospheric shell which is not affected, in consequence of their density, by the centrifugal force caused by rotation. This force, in fact, only affects the lighter materials, chiefly hydrogen constituting the circulating atmosphere. At the surface of contact between the two, however, intermixture induced by friction may sometimes occur, "giving rise to those vortices and explosive effects which are revealed to us by the telescope. . . . Some of the denser vapours would probably get intermixed and carried away mechanically by the lighter gases, and give rise to that cosmic dust which is observed to fall upon our Earth in not inappreciable quantities."

Then, again, solar observation has revealed to us the undoubted fact that the quantity of solar heat varies from time to time, and that the condition of the photosphere, as indicated to us by the sun-spots, also varies. These are supposed to be accounted for by the circumstance that, as the whole solar system is moving through space with the velocity of 150,000,000 of miles annually, "it appears possible that the condition of the gaseous fuel supplying the Sun may vary according to its state of previous decomposition, in which other heavenly bodies may have taken part."

Since its first publication this theory has been subjected to a considerable amount of criticism. Some of this may be considered as favourable, while some is decidedly hostile. Most writers, however, agree with the theory on some points and disagree on others. Undoubtedly, if we accept all its conditions, we shall have to considerably modify some of our ideas of physical actions. Thus, for example, there is the question of what is known as dissociation, or the breaking up of chemical compounds by the influence of physical agents, such as heat, &c. Now it is almost an axiom in chemistry that the general effect of heat upon a compound is to break it up into simpler and chemically less complex substances, while the abstraction of heat is usually considered to bring about the inverse change. But in the theory it will be noticed that the breaking up of the compounds of carbon and oxygen and hydrogen occurs far out in space where the temperature is a very low one, and the re-combination takes place nearer to the Sun, and at a place where the temperature is much higher. But, as Dr. Siemens has pointed out, there are two things to be considered when speaking of dissociation, *viz.*, temperature and pressure; and he supposes that at a very low pressure, such as exists in space, these gases may be broken up by the absorption of some of the radiant energy from the Sun, although their temperature may remain very low.

The idea of a universal atmosphere, which is necessary for the purposes of this theory, although never prominently stated in our standard scientific works, is yet a very old one, dating from the time of Newton, who first made the assumption. It has been accepted since by many eminent and thoughtful writers upon the subject, including Grove, Humboldt, Zoellner, and Mattieu Williams, who have brought forward other considerations which strongly support their assumption. Moreover, the constitution of such an atmosphere would be similar to that required by the theory.

For the criticisms which have been given and Dr. Siemens's replies I must refer the scientific reader to a work published by the latter gentleman, entitled the "Conservation of Solar Energy," and also to the pages of the "Philosophical Magazine." An exhaustive, or even a cursory, notice of these is beyond the scope of the present article.

The thanks of scientific men generally are, however, due to Sir W. Siemens for bringing prominently forward and formulating so ingenious a theory; their attitude with regard to it is one of waiting for further experimental evidence, and this evidence the lamented death of its illustrious author will probably delay.

II. A NEW THEORY OF THE TIDES.

By Robert Bell.

THIS article is intended to show that, although the moon is the chief factor in producing the tides, it is done by a different process than by attraction.

As an illustration, place a parcel of goods that is wrapt in paper on a table, and then push the parcel from you. The first thing that takes place in this last act is, that you make an impression on and disturb the envelope. Now this is exactly what takes place when the Moon, by means of her radiations, is giving the Earth a push.

Owing to the extreme susceptibility to pressure of the envelope that surrounds the solid portion of the Earth,—*i.e.*, the atmosphere,—a part of it is forced laterally in every direction, until it reaches that part of the Earth's sphere at the greatest point of elongation from the Moon.

There is now a greater quantity of atmospheric matter pressing on the water at this point than under the Moon, or at the opposite side to the Moon. The water yielding to the pressure will be depressed at this point, and correspondingly raised under the Moon and at the opposite to the Moon. But the tide on the side nearest the Moon, all other conditions being equal, should be a little higher than the tide on the opposite, because, although the pressure will be equal at the place above indicated, the resistance at the other parts will not be equal, since a portion of the atmosphere on the side next the Moon has been forced away, while that on the other side retains its normal condition.

But why is it that the Moon's radiations do not force the atmospheric wave far enough around the sphere to prevent the water from rising on the other side? There are two reasons for this; and if the Earth always presented the same unchanging face to the Moon as the Moon does to the Earth, such a condition would partly exist. But the rays of the Moon are not felt on the other side, particularly so on account of the Moon's rays diverging as they pass the Earth; also, as the Moon apparently moves around the Earth, she is continually repelling the atmosphere on the one hand, and withdrawing her pressure from the other, thus permitting the atmospheric wave to return at this point sufficiently near to occupy its former relative position to the Moon, as it takes a little time for the Moon's rays to have their effect on the atmosphere, and also a little time for the atmospheric pressure to have its effect on the water. We can easily understand why it is that the tide is always behind the Moon. The atmospheric wave, above referred to, is the cause of the diurnal variations of the barometer; and if there were no local disturbance to the atmospheric wave, and none to the ocean wave, the barometer would be a perfect indication to the height of the tides,—*i.e.*, when it would be high tide it would be low barometer, and *vice versâ*.

Admitting the above theory of the tides to be sound, let us consider what effect it would have on the Moon. If the volume and density of the atmosphere and water of the Moon are in proportion to those on the Earth according to their relative mass, then in this case the radiant force of the Earth would force the whole atmosphere of the Moon to the other side, and if there is any water on the Moon it would necessarily be all on this side, and if there is no water on this side it follows that the Earth's radiant powers have forced the water also to the other side of the Moon, in which case there would be a tranquil sea on the other side, with neither tides nor storms to disturb its calm repose.

Stonewall, January 2, 1885.

III. BELL BUOYS, AND BUOY SIGNALLING.

By Rev. Samuel Barber.

ANYONE who knows the history of the wrecks which have occurred on the Cumberland coast, especially between Seascale and Whitehaven, and thence to Maryport, must be impressed with the want of sufficient warning to vessels, at night, and in the case of fogs occurring. The use of a lightship by way of direction is obvious, but often when most needed these are invisible, and the only apparent alternative is a Sound Signal. The Bell Buoy at the entrance to the Mersey has long suggested an extension of this useful method of indicating position, but this has unfortunately been too little adopted by those who regulate matters on our coasts. The want of two or three such buoys near the rocks at prominent parts of the coast abovementioned has probably resulted in the loss of many vessels and of some human lives.

I therefore venture to draw attention, again, to this matter. There can be little doubt that mechanical science is equal to constructing and placing these useful signals in the positions indicated. The use of a lighthouse is one thing, that of a bell signal another. And although it is necessary that lightships be provided with fog-horns, and thus partially answer the purpose of a bell buoy, the expense of multiplying such ships will always preclude their doing duty for such buoys.

It may perhaps be objected that there would be a danger of confusion resulting from any large increase in the number of such bell-signals. My reply is that of course it is *possible* to needlessly multiply them, but the purpose here advocated is the indicating by sound-warnings the more dangerous points of rocks, sunken rocks, banks, and currents, especially wherever experience has shown that disaster is most likely to happen.

Now, in a fog, a single bell can give but little indication of the direction in which a vessel is moving. *Some* indication will indeed ensue from noting whether the sound increases in loudness or dies away, and to a ship approaching land this would be of great value; but the main use of a *single* bell would simply be to warn off from the point where it was placed.

In such places, however, as it is important to give a definite idea of direction, I may suggest that *two* bells placed some little distance apart—say from a quarter to half a mile—might, to a certain extent, do the work of lightships or lighthouses. A distinct variation of sound being given to each bell so placed, and the nature of each being noted on the published directions to mariners, position and direction may approximately be ascertained by noticing the relation which the sounds bear to one another, and the manner in which each tone increases or diminishes in intensity. The direction N. S. or E. W., &c., of a line from one to another should of course be known to captains.

Wherever advisable, and especially near sea-ports, it would be a valuable addition to buoys, so placed, if they were provided with an additional bell worked by an electric current, and communicating with the nearest sea-port by a cable. Thus, for example, matters relating to anchorage and docking, or the extent and position of fog, &c., might be made known to a vessel lying off (when the state of the sea allowed it) in such positions as are beyond the range of ordinary signalling.

It would be interesting to have a list of such buoys as are placed in deep water, with particulars as to mooring, depth of sea, and special features in construction.

The question arises—Have cables, stretched from one coast to another, or from the mainland to islands, been sufficiently utilised as a base from which to suspend the buoys?

I will conclude these remarks with another question, for electricians. Could a buoy connected with the land by a cable, and having a smaller float attached with a chain, be so constructed as to become a medium of communication between shore and vessels afloat? It would not be difficult for a ship to pick up such a chain and float, and to join wires. The larger steamers already carry electrical apparatus in many instances. It would appear that the experience of Atlantic cable-laying has gone a long way towards solving this question, and the remainder seems to be a problem for mechanics rather than electricians.

Seascale, Cumberland.

IV. PSYCHOGRAPHY.

By R. M. N.

THE remarkable phenomenon known as Psychography is exciting very general attention. The question of its genuineness, and, if genuine, of its nature, is being acrimoniously discussed. One distinguished *savant*, taking unwittingly a leaf out of the book of the Bestiarians, wishes to suppress research in this direction by the blundering arm of the Law. Even the *ultima ratio stultorum*, the formal appeal to Plutus, has been duly invoked. Surely therefore it is time that these alleged facts should be studied in the same calm, cold manner, and with the same indifference as to possible results, as are customary on the announcement of the discovery of a new planet or a new metal.

A word as to my point of view. I am no "Spiritualist." Certain of the doctrines of Spiritualism, as I apprehend them, would be to me highly unwelcome; but to refuse the investigation of novel or unexplained phenomena on such grounds is assuredly unworthy of a man of Science. We cannot dispose of truths by the simple process of shutting our eyes and denouncing their discoverers as "skunks."

The facts of so-called "Psychography" are simplicity itself, and will need here merely the barest recapitulation. Two persons meet in any ordinary room: one of them, the so-called medium, sits quietly in a chair, generally near a table of ordinary construction. The other person, whom I will call the investigator, takes two clean slates, binds them firmly together with waxed thread, having left between them a fragment of slate-pencil or of red chalk, and lays them on the table. The medium places his hand upon them, and in a short time, supposing the experiment successful, a sound like that of writing is heard. On untying the slates one of their inner surfaces, or sometimes both, is found covered with writing, whilst the slate-pencil or other material is found worn down as if it had been used.

The features of the experiment have been much modified on different occasions. The slates used are sometimes taken by the observer from a heap kept for the purpose by the medium, and before being used are carefully cleaned by the observer with a sponge and water, and rubbed dry with a cloth. Not unfrequently the observer brings with him a pair of new slates which he has bought on his way to the medium's house. In some cases a double folding-slate has been used, secured by a lock.

The position in which the slates are laid after being secured together has also greatly varied. Sometimes they are laid *on* the table, the medium touching them with one hand. Sometimes the medium holds them against the under surface of the table with one hand, whilst with the other he holds the hand of the spectator. Again, the spectator has held them upon his own head with one hand, whilst with the other he clasps that of the medium. Or they may be laid upon the table, and never touched by the medium at all. All these experiments, it is well to remember, are performed in full, open daylight.

The nature of the table used, and of the chair in which the medium sits, is a matter of indifference. Both have been carefully examined without disclosing any mechanism or concealed appliances whatever. Other tables and chairs have also been substituted; but the phenomena are unaffected.

Something must also be said concerning the subject-matter of the writing. Very frequently the observer writes some question upon the slates before closing them up, and receives a definite answer,—occasionally touching matters known to no living person but himself, and of which the medium cannot be supposed to have any knowledge. Such answers may even be given in languages with which the medium is unacquainted. Nor must it be forgotten that the observer is sometimes asked, after putting both a bit of pencil and a piece of red chalk between the slates, with which shall the expected writing be produced? And the result comes out accordingly.

It is not, I think, necessary to go more closely into the details of psychographic experiments, since they may be found given with considerable minuteness in various works and journals. But the question is, How are these recorded phenomena to be explained?

The first attempted solution is, if nothing else, remarkable for its sweeping character and for its simplicity. The spectators, we are told, are all conscious and intentional liars. Such an explanation scarcely admits of discussion. To most minds it will be utterly inconceivable that a number of persons, of different ages, nationalities, prepossessions, habits, and thought, should agree in forging a falsehood from which they could reap no manner of advantage. Most minds will conclude that were such the case some one witness, at least, would have come forward to expose the fraud—an exposure which, in not a few quarters, would be exceedingly welcome. How, then, on the hypothesis of falsehood, do Spiritualists contrive to seal the lips of each succeeding spectator?

The next hypothesis is that the spectators, though not intentional deceivers, are self-deceived, and fancy that they see occurrences which never took place. Or they are pronounced to be incompetent, untrained observers. A moment's reflection will show that this supposition cannot hold good. In the first place must be noted the extreme simplicity of the phenomena. There is nothing to excite any passion or emotion; nothing to engage ear and eye, and thus draw off the attention of those present from what is being done, or rather from the manner in which it is effected. There is nothing that requires the trained observer or the scientific specialist. Were it a question turning on delicate spectroscopic or microscopic observations I should not for a moment accept the evidence of a non-specialist, however highly educated, intelligent, and upright. But this is not the case: any sane man of common sense and fair moral character can decide as well as Professor E. Ray Lankester whether the slates used were clean before being tied together,—whether the medium had, or had not, the opportunity of tampering with them,—and whether, when untied, they were found covered with written matter. I repeat it that, to my apprehension, the most illustrious man of Science would have no advantage in making such observations.

But I may be told that it is all clever jugglery. Jugglers can certainly do very surprising things, and they are in these days a prosperous and influential class, whose honour and reputation the Law appraises at a high figure. But I may at least, without fear of an action for libel, assert that their power has its limits.

No juggler has as yet reproduced the phenomena of "Psychography" as above described, and under test conditions. If Maskelyne and Cooke will, like Eglinton, sit down at an ordinary table, and, without apparatus of any kind, produce intelligible writing between two locked slates, which never pass into their hands at all, and which they thus have no opportunity of manipulating, we may then with a show of reason refer this matter to jugglery.

But let us examine this part of the subject a little more closely. How can jugglery be conceived as possibly producing the results described? It may be said that the writing pre-exists on the slates before they are tied together, and becomes visible in consequence of the escape of — a something. This hypothesis is not easily reconciled with the circumstance that, even when the slates are the property of the medium, they are selected by the observer at haphazard from a heap, and are well cleaned and carefully examined by him before being tied together. But it is put completely out of court by the fact that the slates are often brought by the intending observer, and have never even been seen by the medium or by any possible confederate.

The next supposition is that the medium unties or unfastens the slates after they have been fixed together, executes the writing, and fastens them up again as before. We will take the case most favourable for this view,—that, namely, where the medium holds the slates against the underside of the table with one hand, his other hand and all the rest of his person being full in the view of those present. Are we to admit that with that one hand he unties the slates, supports them and the strings or tapes, performs the writing, and ties the slates together again? If so, great is our faith. It may be urged that there are supports beneath the table, by which the slates, string, &c., are upheld while the medium is writing. I reply that the table has been examined, and that no such contrivances are to be found. But how about those cases where the slates lie all the time open to view, upon the table or on the head of the observer, the medium not touching them at all? Such are crucial instances which completely overthrow this unfastening and writing supposition.

I have also heard it insinuated that the slates upon which the writing is found are not the same pair which have been formally prepared, these latter having been dexterously conveyed away and others substituted. This hypothesis is negatived by the cases where the slates remain in view, and are never handled by the medium. It also fails to account for the fact that slates brought by inquirers, and marked privately without the knowledge of the medium, are expressly found not to have been changed.

"The effects are due to electricity or something,"—the something being, I will charitably suppose, some other possibly as yet unknown form of energy. That electricity can produce strange effects I shall not question. Nor shall I dispute that there may be forms of energy still more wonderful. But the table and the seat of the medium contain no hidden batteries, no secret conductors. They may, as I have already pointed out, be exchanged for others. They may also be removed to any other part of the room, or to another room,—a step by which any physical arrangements would necessarily be frustrated. Nor has any spectator detected the presence of electric or magnetic currents on or near the table.

We may go further: electricity, magnetism are not intelligences. By their means it is indeed possible to transmit messages, questions, or answers from one place to another, and to reproduce them in speech or in writing; but there must be an intelligence at the other end of the line. It is utterly inconceivable that electricity or any physical force should of itself combine letters into words, and words into intelligible sentences, conveying often a precise and accurate reply to a question put. It is known that an electric commotion passing over a telegraphic system will sometimes set the instruments at work; but the messages thus sent are mere random combinations of letters, which never—save by rare chance—form even a word, and never certainly an intelligible combination of words. Should such a thing ever happen every experienced telegraph operator would feel sure that some trick had been played, and that the message was not and could not be the outcome of an electric storm.

The writing, it seems to me, must indubitably be produced by some intelligence. But what intelligence? Not by a man; for, in addition to the fact that the crumb of pencil or chalk is generally too small to be grasped by human fingers, we have invariably the testimony that no person has or could have in any way interfered with the slates. Surely we are thus driven from post to pillar until we have but one alternative remaining,—the assumption that there must exist around us intelligences invisible and capable of interfering with the course of events, with what we are accustomed to call the order of Nature. What these intelligences are, what is the extent of their power, and under what conditions it is exerted, I am utterly ignorant. They may be, as the Spiritualists hold, the "spirits" of departed human beings; or they may be the "spooks" or "shells" of the Theosophists, the "elemental spirits" of the Rosicrucians, or the fiends and familiars of mediæval sorcery. To which of these classes the agents in question belong is still an unsolved problem. The Spiritualists allege that the minute acquaintance which these intelligences show with family secrets, with private conversations formerly held between the investigator and the deceased friend, prove their identity with such friends. But it is replied by other persons, believers all the same in the reality of Psychography and of kindred phenomena, that if we are surrounded by invisible intelligences they may know our past careers, our actions, our words, perhaps even our thoughts, and may thus easily assume the part of some friend whom we have lost. It is even conceivable that these invisible intelligences may not be spirits at all, but strictly material beings, capable of acting in 4- or 5-dimensional space, as expounded in the last issue of the "Journal of Science," and which under all ordinary circumstances escape our perceptions.

Hence it seems to me premature to pronounce these and similar manifestations a refutation of Materialism. It is probably still more premature to infer from such phenomena the continued existence of man after what is ordinarily called death. On these points Psychography does not appear to give any definitive assurance.

But the conclusion seems to me unavoidable that if unseen beings, be they spiritual or material,—whatever these terms may mean,—can interfere with the cause of Nature, we have no longer any assurance that like causes will be followed by like effects.

To give an instance: every man who knows that fuel has been laid in a stove, and who some hours afterwards finds it blazing, will conclude—perhaps I must say "would have concluded" until lately—that some human being had set it on fire. Yet we find it recorded in "Light" that a certain family were regularly accustomed, on rising in the morning, to find their kitchen fire had been kindled by some invisible being. Now if "spirits," or 4-dimensional beings, can thus interfere, what confidence can we have in the results which we obtain in our chemical and physical laboratories? In fact it is hard to say what basis remains on which Science can be built.

I read, in a recent article in the "Journal of Science," how an eminent chemist points out the necessity of performing toxicological investigations in a laboratory to which no one but the operator can have access, lest some interference, intentional or accidental, might take place. But if invisible agencies can interfere, how are they to be excluded?

Bearing in mind these considerations, Spiritualists might well speak in a milder tone of the reluctance of scientific men to accept their results. Of course an unpleasant truth is not the less true if we close our eyes to its evidences and to its existence. But what if the activity of the last forty years has made possible what before was impossible? How if the little "tap, tap" of Spiritualism has not merely "shattered the marble image of Materialism," but broken down a partition-wall which barred out invisible agencies from interference in our world? In that case it strikes me that the refutation of Materialism has cost us far too dear.

V. THE LIMITS OF SANITARY REFORM.

HYGIENE, or as we Britons prefer to call it "Sanitary Reform," is of far wider scope than we commonly suppose. If fairly studied it will be seen to involve something much more than a "policy of sewage,"—something weightier than the appointment of costly commissions, Royal or Parliamentary, the purification of rivers, and the suppression of a few desultory nuisances. It includes war against every custom, every institution which tends to debilitate our population, whether it be of a direct or an indirect nature. Taking its stand on the old axiom "Salus populi suprema est lex," it claims precedence alike over the dogmas of political economy and over the dictates of political party. "Direct or indirect" we say. The man who shoots down or stabs his neighbour in the street does ill; but the man who intentionally, and as a matter of business, gradually undermines the health of his neighbour, does still worse. For the man suddenly and directly murdered does not, on that account, necessarily leave an enfeebled, debilitated posterity; but the man who (say) in the third decade of his life succumbs to unsanitary influences, very often leaves to his children an inheritance of what is absurdly called "delicacy." Hence the effects of indirect murder are progressively cumulative,—a continual supply of the "unfittest" being thus provided that they may be trodden down in the struggle for existence.

We have made war, and with a certain measure of success, against typhoid fever, dysentery, scarlatina, cholera, and other diseases comparable to the direct homicide. But what have we done against pulmonary consumption, scrofula, heart and brain diseases, Bright's disease,—in short against all those maladies which, like the indirect murderer, slowly prostrate their victim, giving him the opportunity to procreate an offspring who inherit either the actual specific diseases of their parent or else a general debility which lays them open to every form of sickness? What have we done towards the extirpation of such diseases? Nay, rather what have we done to promote them? Have we not taken a variety of steps to encourage "worry,"—that is, work under the pressure of anxiety? This most debilitating condition lies at the very root of our system of competitive examinations. It is a known fact that on medical investigation a considerable proportion of the *successful* candidates for the India Civil Service have been found to be suffering from albuminuria, the result of the recent strain upon the nervous system. Of course accurate statistics of the number of candidates, successful and unsuccessful, physically injured by preparing for "an open examination" cannot be obtained. Government would assuredly discourage and thwart any attempts in this direction. Could the anti-hygienic results of this scheme be fully laid before the nation they would almost unanimously decide that some more excellent way of selecting candidates for appointments must be adopted.

But we have no time to enlarge upon this part of the subject. Public elementary education has been also cleverly converted into a machine for the promotion of general debility. The disclosures recently brought forward by Dr. Crichton Browne are still fresh in the public mind. No less fresh are the attempts made by officials to keep their own eyes and those of the nation closed against these startling revelations, and the somewhat lame and impotent conclusions reached after due consideration. The official mind refuses, above all things, to see that the root of "over pressure in education" is the Satanic device of "payment by [pseudo-] results." But on this subject also we cannot stay to enlarge.

It has been asserted that the Englishman of to-day is not inferior, physically, to his forefathers of fifty or a hundred years ago. We question whether this conclusion rests upon a sufficiently broad basis. But to avoid a discussion for which conclusive data are wanting let us admit that the country gentleman, farmer, farm-labourer, or navvy of this day is as healthy and vigorous as was respectively the country gentleman or farmer, &c., of the year 1830, and in like manner that the town-bred workman or shop-assistant of 1880 is physically equal to his predecessors of half a century ago.

Even then there remains the grave fact that a far greater proportion of the nation is placed under less favourable circumstances as regards health than was the case at the beginning of the century. We must admit this fact, unless we are prepared to deny the progressive depopulation of the open country and the concentration of the people in the great cities. This means a relative increase of men doomed to occupations either sedentary, or, if involving physical activity, still exercised in the absence of a sufficiency of light and fresh air.

It is only from this point of view that we can realise the true meaning of the present agricultural depression. Every thousand acres of land thrown out of cultivation, or laid down to permanent pasture, means so many men and women driven from the free air of the country to the slums of London, Liverpool, Glasgow, and the like. Perhaps one of the noblest tasks which a true statesman could undertake would be to devise a remedy for this desertion of the open country. But our professional politicians of both parties look on in "sick stupidity" while the deadly game proceeds.

Mr. James Cantlie, in a lecture recently delivered at the Parkes Museum, has uttered a sound of warning. He took for his subject the "Degeneration amongst Londoners." Now if we bear in mind that London contains about one-eighth part of the population of Britain, and that our other large towns—where the vital conditions are essentially similar—raise the proportion to one-sixth, this degeneration is indeed a hand-writing on the wall.

Mr. Cantlie is reported to have described London as "an ozoneless region, where exercise in fresh air is impossible to obtain, and where the sun's rays are deprived of all health-giving power." The supposed effects of ozone, or of its absence, we are not about to discuss, since its existence in the atmosphere has not been proved with sufficient precision. But the difficulty of obtaining exercise in, or even mere access to, fresh air we fully admit. Nor can we deny that the sun's rays, even in the suburbs, differ both in quantity and quality from those poured out upon the open fields.

The lecturer defines the normal Londoner, whose degeneracy he discusses, as one whose parents were born in London and spent their days there, and who himself has had the same unhappy destiny. It is, of course, obvious that numbers of the inhabitants of London do not fall within this category. Leaving out of consideration the higher classes, on the one hand, and the vagrant nomadic population on the other, who spend a part of each year only in the great city, we have further to exclude soldiers and sailors, who may be residing in London one year and the next may be at the antipodes. But if we look at the permanently domiciled civil population we shall be surprised to find how many of them have been born and brought up in country districts, and how many more are the offspring of country-bred parents. This is, in itself, a striking fact. It proves that the true-bred Londoner, the cockney of the cockneys, must rapidly die out. This fact is brought prominently forward by the lecturer. He maintains that it is "well nigh impossible to find a third, and absolutely impossible to find a fourth, generation of pure Londoners, the progeny ceasing partly from moral and partly from physical decline and inability of continuance." The pure Londoner of the third generation whom he had been able, after much search and inquiry, to get hold of, was "a type of physical decline, involving diminutive stature, narrow chest, deformity of jaws, miserable appearance, scrofulous diseases, and small head. Pure Londoners are seldom to be found in workhouses, as they die young. They are able to 'light porter,' sell papers, and earn a livelihood by some such shiftless means."

The picture thus drawn of the thorough-bred Londoner applies fairly enough to the aborigines of other great cities, at home and abroad. The Parisian *ouvrier*, we are told, never becomes a grandfather. In Berlin the proportion of young men declared unfit for military service is most signally higher than in the small towns and villages of the German empire.

Mr. Cantlie holds that but one way exists for avoiding the present ills,—*i.e.*, "securing for the young such an amount of beneficial sojourn in a pure atmosphere as shall enable the bodily functions to be performed under circumstances the most favourable to perfect physical development." Here we must presume to differ from him. As the degeneracy of our town-population is due to the combined action of several factors, so a variety of remedial measures are not merely possible, but necessary.

One of these will consist in the introduction of sanitary inspection into regions where it has not hitherto been attempted. It has been found necessary in factories of various kinds, not only for the hours of work to be regulated by law, but for a variety of conditions to be enforced which are considered essential for the health of those employed. But establishments where nothing is manufactured, and where merely sale is carried on, are outside the provisions of the law. Yet some of these establishments are conducted without the slightest regard to health, and exert, in consequence, a most prejudicial effect. State interference is here, in fact, much more necessary than in factories, since in the latter the hands go home at night, if not also during the dinner-hour, whilst in large selling-shops—wholesale and retail—a very large proportion live and sleep on the premises. We have made it our business to collect information concerning the sanitary condition of such concerns, not omitting the monopolist drapers, who are now so common, and we regret to say so prosperous, in all quarters of London. We cannot, of course, name the establishments to which we refer, as independently of the score or more of actions for libel which would be our reward, our informants would reap immediate dismissal, and would be boycotted throughout the trade.

In these shops phthisis and scrofula run riot, the former perhaps more among girls, and the latter among young men. Of this any medical man may convince himself with little trouble; the seamed and knotted necks of the sufferers tell their tale too plainly. No less striking are the narrow, hollow chests, the worn, weary expression of the features, and the sudden flush of the cheeks on any exertion. Now it may be urged that the hands are phthisical or scrofulous, as the case may be, when they enter these establishments. This we deny: many of them are enticed up from the country by delusive advertisements; but the conditions under which they are placed are admirably adapted to foster any tendency to disease. Deficiency—or rather absence—of ventilation, and an atmosphere charged with the products of the combustion of gas,—which in these shops is burnt in prodigious quantities,—are prominent elements of evil. The sleeping apartments are small, and, especially as far as girls are concerned, two have to sleep in one bed, the one perhaps already consumptive. Then there is the absence of open-air exercise. From morning to night the whole time, substantially, is spent in a standing position, which fatigues much more than does a brisk walk.

Some time ago an outcry was raised touching the cruelty of thus compelling girls to stand for the entire day, and not permitting them to sit down even in the entire absence of customers. Some shopkeepers were, we believe, shamed into allowing their shop-girls to sit down when disengaged; but this trifling amendment soon melted away. We have heard of cases where girls have been savagely reproached for leaning on the counter when at liberty. We know even of an instance where the head of a certain firm removed with his own hands, from one of the "departments," a chair which had been placed there for the use of customers, lest the assistants should sit upon it. Pulmonary consumption and scrofula are not the only diseases which flourish in these establishments. From the information which reaches us we believe that acute rheumatism — commonly known as rheumatic fever—is very rife. Hysterical affections are also frequent among the female hands, due evidently to the generally depressing influences which surround them, and in no small extent to the bullying language of the "shop-walkers."

The hours of work are far longer than the outside world is aware. The hands are often kept busy for some time at night after the doors are closed to the public. Indeed, when preparations are being made for one of those farces duly advertised as "our annual sale," "our clearance sale of winter goods," &c., it is nothing uncommon for some, at least, of the *employés* to be kept hard at work till 2 a.m., or even beyond,—an addition to the day's work for which no extra consideration is given, such as, *e.g.*, the carpenter or the bricklayer enjoys for overtime. Stock-taking is another occasion on which work is prolonged *ad libitum*.

As regards what are euphemistically known as the "sanitary arrangements," they are too often grossly inadequate to the number of persons on the premises, and generally speaking in bad order. Sometimes an unpleasant odour even reaches parts of the premises to which customers have access.

During the time of the "sales" above referred to it has even happened that these conveniences have been locked up for a considerable part of the day, lest the employer's precious time should suffer. What influence this must have on the health of the hands needs surely no expounding. It is likewise customary for the doors leading to the sleeping apartments to be locked all day, an arrangement which, as far as the female hands are concerned, is under certain circumstances exceedingly prejudicial to health.

The exposure to cold is, in times of fog, frost, keen winds, or damp, exceedingly hurtful, especially as the victims cannot counteract its effects by brisk exercise. In some of these establishments the girls take breakfast in a cold room, go down to their work in shops which are not provided with any warming appliances, go to dinner in a cold dining-room, and have then the privilege of spending the residue of their dinner hour in a fireless sitting-room. Not until the day's business is over, say 8 p.m., is a fire lighted in this room.

Thus, however severe the weather, these ill-fated girls never have the opportunity of warming themselves until between eight and nine in the evening. That in some of these establishments the food is of doubtful quality, ill-cooked, and little qualified to stimulate an appetite not kept in tone by out-door exercise, is another count in the indictment.

These anti-hygienic features are not to be met with to an equal extent in all the sale-shops and warehouses where large numbers of hands live and sleep "in." But our information is mainly derived from establishments which rank among the best-conducted of their class.

Another point, which perhaps scarcely comes under the head of Hygiene, is that the hands have rarely an opportunity of taking air and exercise until about nine in the evening. How ill-adapted the streets of London are for this purpose, in the case of young women, does not need to be demonstrated. It will thus be seen that we have here powerful, efficient causes of physical degeneracy and of positive disease affecting a very considerable proportion of the population. Mr. Cantlie's proposal leaves this source of evil absolutely untouched.

It may be forgotten that in the rise of the factory-system the scheme of "living in," in so-called "bothies," was tried. Their necessary suppression gives a precedent for similar measures elsewhere.

Further information concerning the hygienic shortcomings of shops and warehouses, as well as of failures in health consequent upon "preparing" for examinations, is earnestly solicited, under the strictest confidence.

VI. THE SUGAR INDUSTRY.

By Robert Galloway, M.R.I.A.

WHEN I wrote the article on the extraction of sugar from the juice of the cane and the juice of the beetroot which appeared in the September number of the "Journal of Science," I had no personal knowledge of the condition of the sugar manufacture in the Island of

Mauritius, nor had I met anyone who was practically acquainted with the industry in that Colony. Since then I have become acquainted with a gentleman who is the proprietor of a large sugar estate in that Island, and who has himself lived there, and is, therefore, will acquainted with the sugar manufacture as it is carried on in that Colony. The information he gave me coincides with what I had already stated with regard to our West Indian Sugar Colonies. In the Mauritius they extract, he informed me, only seven out of every twenty parts of the sugar which is present in the cane juice. This great loss of nearly two-thirds the amount is not attributable to the non-employment of the best machinery; my acquaintance, for example, has the best modern machinery on his estate, and it has cost him £30,000. It is therefore evident that on this estate as on those I visited in the West Indies, the loss in sugar arises chiefly from the imperfect purification of the juice. My acquaintance said to me "You are perfectly correct in stating that the loss sustained is owing to the want of skill and intelligence." He said, "I am almost surprised that we extract even as much as we do, for neither the proprietors, nor the managers, nor anyone connected with the industry know anything about the manufacture beyond mere rule-of-thumb." "If we could only," he said, "obtain ten parts instead of seven, of the twenty which exists in the juice, it would render us prosperous in spite of the importation into England of the bounty fed continental beet-sugar." As an instance of the want of skill and intelligence, native boys, after a fortnight's training, are given the sole charge of the vacuum pan. To illustrate the loss that may be sustained from intelligence not conducting this one operation alone, I will mention a case I became acquainted with some time ago; a change in the method of purifying the sugar solutions having been accomplished in a factory whereby the saccharine solution was rendered purer caused a serious money loss to the owner, and the process was credited with it, whereas it was due to the rule-of-thumb man who boiled the sugar solutions; he could not manage these purer sugar solutions in the pan—crystallisation taking place more rapidly than was the case with the impurer solutions he had been accustomed to boil—and he, as is usual with such men, concealed his want of skill from his employer by tricks and artifices; the money loss sustained being attributed to the process.

I inquired of the Mauritius proprietor how they disposed of their molasses. He said formerly distillers in the Island used to buy it and convert it by fermentation into an inferior rum which they exported to the Island of Madagascar, but since the French commenced hostilities there, that market has been closed to this and other importations. This planter had therefore tried exporting the molasses to England, but what it sold for here did not pay the cost of carriage. He had, therefore, directed his manager to employ it in future as manure.

I am glad to see by "The Sugar Cane" for this month (February), that the Committee of the Agricultural Society for Barbadoes have drawn up a series of resolutions on the Central Factory System, and have sent a copy to the proprietors of the different estates on the island. The following is the first resolution:—

"That central factories are desirable as the most practical means of rendering the manufacture of sugar in this island profitable."

English investors need not, therefore, in future seek out such distant and hazardous places as the Argentine Republic if they wish to invest their money in the sugar manufacture; they will doubtless soon have an abundant opportunity of investing their money in that industry in our own Colonies. Then, again, what a splendid opening this establishment of Central Sugar Factories in our colonies would have been for our young chemical engineers if we had established a sound system of Technical Education, instead of that most inefficient and miserable, but very costly system, established by the *Military* at South Kensington.

ANALYSES OF BOOKS.

Forty-five Years of Registration Statistics, proving Vaccination to be both Useless and Dangerous. By A. R. WALLACE, LL.D. London : E. W. Allen.

IN this little work Mr. Wallace attempts to prove, by official statistics, the four following propositions :—

1. "That during the forty-five years of the registration of deaths and their causes smallpox mortality has very slightly diminished, while an exceedingly severe smallpox epidemic occurred within the last twelve years of the period.
2. "That there is no evidence to show that the slight decrease of smallpox mortality is due to vaccination.
3. "That the severity of smallpox as a disease has not been mitigated by vaccination.
4. "That several inoculable diseases have increased to an alarming extent, coincidently with enforced vaccination."

It must be admitted by all observers that we are far, very far, from having got rid of smallpox, as at the introduction of vaccination it was promised and hoped. The disease still clings to us, in spite alike of vaccination and of sanitary reforms. But the question is, whether this failure is due to the inefficiency of the supposed safeguard or to its very frequent neglect ? The figures here quoted show that, according to Dr. Seaton's evidence before a Parliamentary Committee in the year 1871, the average vaccinations were only 49·46 per cent of the births. So that about half the infants born escaped vaccination. This was of course after the introduction of the present law, which came into force in 1867. It may be asked, What is the present proportion ? Judging from the curve showing "efficient vaccination," in the author's second diagram, a still larger number of infants now are unvaccinated.

The author declares that "there has not been any gradual extension of the practice of vaccination, but, so far as official records go, just the reverse." We are well aware that the relative numbers of infants vaccinated and unvaccinated do not show the proportion of the vaccinated population. Still it is evident that a very considerable part of the nation is unvaccinated, and the defenders of the practice are—as far as this part of the argument goes—warranted in saying that vaccination has not yet received a fair trial.

This compels us, overstepping for the moment the second and third propositions, to turn to the fourth,—the increased prevalence of diseases which may be, and in certain cases actually have been, communicated by vaccination.

Among these rank syphilis, cancer, tabes mesenterica, pyæmia, and skin disease. In all these a steady increase must be admitted. Thus in the four years 1850 to 1854 the average death-rate in England from syphilis was thirty-seven per million of the living population; from 1875 to 1879 it had reached eighty-six; and from 1878 to 1880 eighty-four!—an increase of more than 100 per cent. But if vaccination is a main factor in the spread of syphilis, it is strange that an *increase* in the latter should coincide, as Mr. Wallace's curve and his quoted words alike show, with a *decrease* in vaccination. The same remark applies, of course, to the other inoculable diseases.

The statistical argument that smallpox has not been mitigated by vaccination seems to be decisively made out. The proportion of smallpox cases occurring is duly recorded. So also is the number of deaths. But on comparing these figures it is found that the proportion of deaths to cases is little lower now than it was before the introduction of vaccination. The most trustworthy returns available, from the years 1723, 1746 to 1763, and 1779, give a general average of 18·8 per cent.

In our day Mr. Marson's returns, 1836 to 1851, and the reports of the London, Homerton, Deptford, Fulham, and Dublin smallpox hospitals, from 1870 to 1880, give a general average of 18·5. This is surely a trifling gain if we remember that medical science has made great advances since 1779, and that the management of hospitals has been notably improved. Yet all this progress, with vaccination to boot, only scores the pitiful decrease of 0·3 per cent!

The strongest part of Mr. Wallace's case is drawn from military and naval statistics. All soldiers and sailors are vaccinated on joining the services, whether they have been previously vaccinated or not. Being a picked body of men, in the prime of life, they are healthier and stronger than the general average of the male population. They are placed under constant medical supervision, and enjoy ample food and fresh air. Yet the death-rate from smallpox in the army is 83 per million, and in the navy 157 per million. On the contrary, the smallpox death-rate among the adult male civil population, including the unvaccinated, the weakly, and the diseased, ranges in five of our large towns from 89 to 131 per million. Yet our soldiers and sailors have the advantage of passing some part of their term of service in the Tropics, where *smallpox* is less prevalent. Surely if re-vaccination were the safeguard which it has been considered, the army and navy ought to be exempt from smallpox. We find no evidence to show whether vaccination from the calf gives better results than does the transfer of vaccine lymph from one human being to another. Perhaps statistics on this point are not procurable.

The greatest difficulty connected with the subject is to understand how, if Mr. Wallace is in the right, such a vast majority of medical men uphold the practice. The fees for vaccination are small, and if the profession were so much under the dominion of self-interest, as it is asserted by anti-vaccinationists, they would be reluctant to check the spread of a disease every case of which must bring them more emolument than a dozen vaccinations.

Nature's Hygiene. A Systematic Manual of Natural Hygiene, containing also an Account of the Chemistry and Hygiene of the Eucalyptus and the Pine. By C. T. KINGZETT, F.C.S. Second Edition. London: Baillière, Tindall, and Cox.

THIS work, since the appearance of its first edition, has been much enlarged, and indeed to some extent re-written. Its first part now forms a very complete manual of hygiene, whilst the second is devoted to the special consideration of the Pine and the Eucalyptus as sanitary agents. The title selected, "Nature's Hygiene," is significant, since it is the author's especial object to point out the existence and the *modus operandi* of natural means for the destruction, or at least repression, of zymotic disease.

In certain introductory chapters, containing chiefly matter with which our readers will be perfectly familiar, the author shows that the great natural disinfectant is hydrogen peroxide, —the occurrence of ozone in the atmosphere being by no means decisively established. Whatever processes, therefore, whether in the organic or the inorganic world, by which hydrogen peroxide is evolved, must of necessity contribute to sanitation.

From these generalities we pass on to consider the author's views on some of the great hygienic questions of the day. Mr. Kingzett regards the inorganic constituents of water as unobjectionable in drinking-water. This is a rightful protest against the Sensationalism which summed up carbonate of lime amidst the impurities which alarmed Londoners were said to be swallowing by hundreds of tons. But our author would agree that lead present in water renders it unfit for drinking-purposes, as decidedly as can putrescent matter. And though the recommendations of the late Rivers' Pollution Commission, which

> "schleppen sich
> Wie eine ewige Krankheit fort,"

fix no bounds to the proportion in which magnesian salts may be poured into a river, their action is in the long run decidedly unsafe.

In discussing the condition of the Thames above London, Mr. Kingzett makes a statement which cannot be admitted. He writes:—"The treatment of sewage, as here referred to, means the removal therefrom of the whole of the suspended matters, but it does not seriously affect the composition of the liquid part (effluent) which is then discharged into the river." But, if the treatment is properly performed, soluble organic matter, such as soluble albumen, will be coagulated, precipitated, and removed. We may withdraw from town sewage, by the most careful and reiterated filtration, all suspended matter. Yet on adding to the filtrate solutions of certain metallic salts,—preferably perhaps of aluminium chloride,—a precipitate is produced consisting of a compound resembling the "lakes" of the colour-maker and the dyer.

In examining the dogma of the Rivers' Commissioners, that "Rivers which have received sewage, even if that sewage has been purified before its discharge, are not safe sources of potable water," Mr. Kingzett presses the question—How is it, considering the quantity of organic matter introduced into the Thames, that its water is so comparatively pure? He points to the various agencies, organic and inorganic, which take part in this purification. According to some experiments made by Prof. W. Odling the water of the Thames loses daily, in passing from Teddington Lock to Somerset House, from 12 to 13 tons of oxygen. It is indeed difficult to say what can have become of this oxygen unless it has been employed in oxidising, or, in plain English, burning up the impurities.

It is of course contended that, whilst dead organic matter is thus burnt up, living organisms—disease-germs—resist. We are told of experiments said to have been made upon them with poisonous gases. If the results described were really obtained it may be asked whether the chemicals used are poisons for these particular organisms, or are inhaled by them at all? We have imprisoned specimens of an animal, very much higher in the scale of being, *Callidium violaceum*, in an atmosphere of hydrocyanic acid, without effect. Other poisons, on the contrary, proved effectual.

In reply to Dr. Hogg's celebrated Caterham case, where a workman suffering from enteric fever had defiled the well, and thus occasioned a disastrous epidemic among consumers of the water, the author shows that the water, though largely diluted, "was immediately delivered for consumption, and certainly was not exposed to those conditions which must be accepted as constituting purifying influences."

It may be here remarked that, concerning the withdrawal of disease germs from water, doctors differ. Unless we are greatly mistaken Prof. Frankland has asserted that water may be freed from bacilli, &c., by being passed through a "spongy iron" filter. Dr. Jabez Hogg, on the contrary, has found such water plentifully stocked with microbia.

Mention is made of the very instructive statistics compiled by Mr. Baldwin Latham, from which it appears that the death-rate from diarrhœa in the districts supplied by the Thames water-companies is actually *lower*, though only to a slight extent, than that prevailing in the districts supplied from the deep wells of the Kent Company. "Such a fact as this," he justly remarks, "is simply irresistible."

Concerning the means of judging of the fitness or unfitness of a water for drinking purposes some difference of opinion prevails. The author relies, it seems, on chemical analysis. He writes :—"By the logical use of the results obtained from the analysis of waters, combined with a knowledge of their history, it is not difficult for chemists to form a sound judgment as to whether they are or are not fit for drinking purposes, notwithstanding all that has been said to the contrary by engineers and biologists. If chemists cannot pronounce positively concerning the presence or absence of disease-germs in water, they can at least ascertain from its composition and history whether it is likely to contain them or not. Engineers can do nothing in this direction, and biologists cannot provide a better test of the purity of water."

We submit that the history of a water is as open to the engineer or the biologist as to the chemist. Chemical analysis may, by direct or indirect methods, ascertain what proportion of carbon and of nitrogen in organic compounds is present. But it is unable to say whether such nitrogen and carbon have been derived from the bodies of disease-microbia or from lifeless inorganic matter.

In his chapter on the treatment of sewage, the author very justly remarks that "precipitation by lime yields an effluent which, from its comparative impurity and alkaline character, soon passes into a state of putrefaction, and the lime in solution is fatal to the fish in river-water."

The farcical proceedings of the Metropolitan Board of Works at Barking and Crossness receive the estimate which they justly merit.

We regret that, from want of space, we cannot at present enter upon a discussion of the author's views on the propagation of disease, the more as he does not implicitly accept the prevailing germ-theory.

Magnetism and Electricity. By F. GUTHRIE. With Supplementary Chapter by C. VERNON BOYS, A.R.I.M. London and Glasgow: W. Collins, Sons, and Co., Limited.

THIS work commends itself to us as containing no reference to any "syllabus," and as being not disfigured with a tail in the shape of questions set at any examinations. It is, as the author informs us, intended for the general student. He also draws an often-forgotten line between Science and Art,—one of the definite boundaries, now possible,—and "where the Science becomes an Art" he does not go into details except the Art supplies a good illustration of some scientific principle.

The "Supplementary Chapter," on the contrary, is devoted to inventions rather than discoveries. It describes, therefore, the telephone, the microphone, various forms of dynamo-machines, the principles of electric lighting, and accumulators, and explains the units now so much employed by electrical engineers.

The brief but ably written chapter on Electricity in Relation to Life is valuable as cutting away the ground from under a certain school of charlatans, and showing how little definite foundation there is for the vulgar notion that electricity is identical with, or at least very near of kin to, life.

This work is one we can in good faith recommend to the general reader who wishes for a rational exposition of the properties and the possibilities of electricity.

Records of the Geological Survey of India. Vol. XVI., Part 4.

AMONG the most interesting papers in this issue is a notice, by Mr. F. R. Mallet, on Native Lead from Maulmain and Chromite from the Andaman Islands. The lead ore in question, obtained by Mr. G. H. Law, is a carbonate of lead tinged bright red by minium. It contains small cavities lined with tiny white crystals of cerussite, and some of them are also partly filled with metallic lead.

Chromite, apparently in quantity, has been found near Port Blair, in the Andaman Islands.

The fiery eruption from one of the mud volcanoes of Cheduba Island, Arakan, noticed on May 2nd, 1883, was evidently due to the ignition of petroleum or of a gaseous hydrocarbon gas. The flame is said to have risen at first to the surprising height of 900 feet.

Records of the Geological Survey of India. Vol. XVII., Parts 1 to 4.

Dr. W. King contributes a memoir on the "Smooth Water Anchorages" of Narrakal and Alleppy, on the Travancore coast. There are two anchorages on this coast which are perfectly smooth and quiet, even though the sea outside is tumbling in before the gales of a south-westerly monsoon. The bottom of these anchorages is composed of a soft, unctuous mud, portions of which, on analysis, are found to contain oil. There appear to be deposits of petroleum, either underneath the sea-bottom or along the coast, from which oil gradually oozes up, and calms the otherwise troubled waters in the manner which has of late attracted so much attention, especially since the Peterhead experiment. To keep up the tranquillity of surface the supply of oil must be continuous.

Mr. R. Bruce Foote, F.G.S., describes the caves of the Kurnool district. The exploration was rendered difficult by the swarms of cliff-bees, *Apis dorsala*, insects of a very uncertain temper.

Mr. R. D. Oldham gives an account of the earthquake of December 31st, 1881, which seems to have been felt over a region 1600 miles from north to south, and 1500 from east to west.

Mr. G. F. Scott, M.E., reports on the Choi coal exploration. He announces that the prospect of finding a sufficiency of workable coal, either at Choi, Mungi, or the country to the east and west of the points, is doubtful. The coal, moreover, is but of a poor quality.

Mr. R. D. Oldham has re-discovered the "long-lost fossil locality described by Sir Proby Cantley, at the base of the section in the Siwalik Hills."

Mr. F. R. Mallet reports on the mineral resources of the Andaman Islands in the neighbourhood of Port Blair. The pyrites of these islands, so far, are of a very low quality. It is remarked that "the poorest class of ore in the English market contains about three times as much sulphur as that of Ráng-u-Cháng. The pyritic quartz has been assayed for gold and silver, and is found to contain none. The writer considers that there is a deposit of chromite, but doubts strongly that it is a large or continuous one. Platinum, which often occurs in connection with chromite, was searched for, but not a single particle was found.

Col. E. B. Sladon gives an account of a further fiery eruption from one of the mud volcanoes in Cheduba Island. On this occasion the flame is said to have been 2400 feet in height and 600 feet in circumference, giving off dense smoke and a smell of petroleum.

Dr. W. King gives a favourable preliminary report on the Raijarrh-Hingir coal-field, and points out localities for borings.

T. D. La Touche and T. W. H. Hughes report on the Langrin and Almaria coal-fields. In the former of these districts the prospects for remunerative coal-mining are very fair. The coal contains but a small proportion of ash, and would hence be suitable for burning the lime which is quarried at the foot of the hills.

At Almaria the position is still better, there being an abundant store of coal fit for railway purposes, and occurring in a working thickness of at least 7 feet. It lies near the surface, the dip is slight, and the coal-measures are not very watery.

Dr. King describes the auriferous sands of the Subansiri River, in Assam. He finds that the yield of 26 ozs. per ton was obtained from a minute portion of sand, and not at all representing the actual output on the large scale. In practical operations in the Lakhimpur district the entire quantity obtained from 2½ tons of stuff was only 30 grains!

The phosphatic beds of Musun afford deposits of phosphate of alumina, containing in the nodules 45·17 per cent phosphoric acid, and in the rock 41·8 per cent.

Mr. R. Bruce Foote resumes his examination of the Billa Surgam Caves. In the so-called Charnel-House Cave traces of prehistoric man were found, at the depths of 15 and 16 feet below the surface, in the shape of a well-made bone gouge and two pieces of stag-horn which had been cut with some sharp instrument. A rude bone-knife was also found in the Cathedral Cave. Bones and teeth of many animal species were found, but their determination was in many cases impracticable on account of the deficiency of the osteological collections at Madras. The caves do not appear to have been the prolonged residence of any Carnivora. The most interesting facts are the discovery of two species of the genus *Equus*, hitherto unknown in Peninsular India, and of a second species of rhinoceros, quite distinct from *R. indicus*, but approaching *R. javanicus*.

Report on the Cotton Production of the State of Alabama, with a Discussion of the General Agricultural Features of the State. By E. A. Smith, Ph.D., State Geologist and Professor of Chemistry and Geology in the University of Alabama.

The climate of Alabama is by no means what might be expected from its latitude, its proximity to warm seas, and from the absence of high mountain ridges. Though the mean annual temperature reaches 64·58° F., and that of the winter 50·4° F.,—higher, in fact, than that of the South of England,—frost is no exceptional phenomenon. In Montgomery, at about 32·4° N. lat., the last frost occurs, as a rule, between the 5th and 25th of April, "and when the last frost is recorded in March its actual formation in April is prevented by unfavourable conditions, such as cloudy weather." In the autumn the first frosts are usually experienced between October 10th and 25th. Thus little more than five months out of the twelve are absolutely safe from frost. In the more northern parts of the State there is usually at least one considerable fall of snow during the winter.

Concerning the local incidence of frosts an observation is made which coincides with experience in England and on the European continent. Frost is often more destructive in valleys than on the hills. This phenomenon is thus accounted for :—As the air is cooled it becomes more dense, and in consequence flows down the slopes to the lower levels, where it accumulates. The elevated lands are thus never exposed to the full intensity of frosts, for their position affords a ready way for the escape of the cooled air, which flows down the slopes as fast as formed, and the reduction of temperature is in this way greatly retarded. On the other hand, the lowlands not only retain the cold air caused by their own radiation, but serve also as reservoirs for the cold air descending from the adjoining heights. Hence narrow valleys and plains extending towards the foot of hills are necessarily less favourable for the growth of cotton, and other crops impatient of cold, than are hills of a moderate elevation.

Report on the Cotton Production of the State of Florida, with an Account of the General Agricultural Features of the State. By E. A Smith, Ph.D.

A FAUNA and flora of Florida would be for the naturalist a document of surpassing value, especially as both will shortly undergo destructive changes from drainage operations and from the projected ship-canal. We find a list here of the most common timber-trees, shrubs, and weeds. One of the most troublesome of the latter is the yellow dog-fennel (*Helenium tenuifolium*). "It is eaten in the spring-time by cattle, and imparts an intensely bitter taste to the milk."

Considering the low latitude of this State (24° 30′ to 31° N. lat.) and the absence of eminences reaching 300 feet, the climate of this State should be semi-tropical. Still frost is not altogether excluded, since we read of the temperature in winter seldom falling much below 32° F.

The peninsular part of Florida was probably elevated above at the end of the Upper Eocene. During the Middle and Upper Tertiary epochs it is probable that Florida was much broader than at present, and that the western coast lay 100—or in some places 150—miles beyond its present position.

One of the most interesting geological features, from an economic point of view, is the plentiful occurrence of a soft limestone, which in some places contains as much as 16 per cent of phosphoric acid.

The Higher Branch of Science or Materialism refuted by Facts. By H. J. BROWNE. A Paper read at the Hall of Science, Melbourne, Aug. 15th, 1884, which was written with the intention of being read at a meeting of the Royal Society of Victoria, but which was declined by the Council of that Conservative Association. Melbourne: W. H. Terry.

MR. H. J. Browne is a man with a grievance. When his paper was declined he appears to have written to the President of the Royal Society requesting that his name might be erased from the list of members of the Royal Society, but being good enough to promise that "when the Society becomes less illiberal and intolerant towards anything that does not accord with received theories, I may allow my name to be reinstated, and if so, I shall take an opportunity of bringing this episode under the notice of the Society."

Without any wish to hurt the author's susceptibilities we must say that had he served on the Council of any scientific society he would have learnt that in discussing the suitability of any paper offered, *two* questions are raised: Is the subject suitable, and is it treated in a worthy manner? Now, in criticising this paper the first question we ask is: where is the science? Mere facts, even if in quantity sufficient to form a shower-bath, do not constitute science. They require to be co-ordinated. Now, this task, so far as we can see, is not even attempted in the work before us. Facts are referred to which it is by no means our purpose to call in question. There is abundance of reiterated complaint about the obstinate materialists who will not "condescend" to their investigation. The opinions of eminent men in favour of Spiritualism are quoted, and there is the *banal* enumeration of cases where truths now generally recognised have been received with ridicule, persecution, or neglect. But calm reflection would tell the author that though truth has often been thus ill-treated, every opinion which is despised and rejected is not necessarily truth. Now all this matter which forms the staple of the book, is scarcely well fitted for the transactions of a learned society. Had the author, instead, stated certain verified facts, explained what they prove, and traced them to definite laws, or even attempted so to do, he would probably have met with a very different reception at the hands of that "Conservative Association."

We all know that—to take a simple instance—the publication of the "Origin of Species" roused a violent storm of opposition. Yet we can find no case where Darwin gave vent to Jeremiads on the obstinacy, the prejudice, or the preconceptions of his gainsayers.

But we find Mr. Browne committing certain palpable errors. He writes :—"It is said that nine-tenths of the men of science of to-day are Agnostics, which I hold is merely a milder and more respectable name for Atheists or Materialists." Now we have certainly no authority to speak as the representative of Agnosticism, which would doubtless, if occasion served, calmly refer us to some sub-species or variety of the "*genus* Humbug." But we regret to find a writer who pleads for the dismissal of prejudice and for the candid judgment of opponents confounding positions so distinctly different as those of the Atheist and the Agnostic.

On the next page is an abuse of language which is of itself enough to justify the rejection of Mr. Browne's paper, unless he had consented to its correction. He writes :—"Those who have witnessed the wonderful phenomena of Mesmerism, *Biology* (!), Hypnotism, and Clairvoyance, &c." Again, a few lines lower down, we read :—"And I hold that no one has the right to deny the truth of Mesmerism, *Biology*, Hypnotism, or Clairvoyance, &c." Now surely Mr. Browne must know that the term biology, meaning the science of living beings, was pre-engaged long before certain persons thought proper, quackishly, to use it for a certain method of producing a state very similar to, if not identical with, Hypnotism. The expression first coined was "electro-biology," but when it was found that a disk of a single metal, or of wood, or horn, &c., placed in the palm of the hand and gazed at persistently answered the same purpose as the compound disc of zinc and copper, the prefix "electro" was dropped, and the new process or method of producing Hypnotism was impertinently and ignorantly named Biology. We should recommend Mr. Browne to purge his pamphlet from this defect.

There is another point on which we must join issue with the author. Unless we fail to understand him he clings to the old notion of an absolute barrier between man and the rest of the organic world. He writes :—"As below man is the animal kingdom, so above him is the spirit-world." Now the very same arguments which may be urged in favour of man's continuance after death tell in favour of a future life for the lower animals also. More; not a few Spiritualists testify to the reappearance of deceased dogs, cage-birds, &c. But we hope that the author, who admits himself a believer in Evolution, does not literally uphold the doctrine of the "great gulf" separating man from the anthropoids.

Second Annual Report of the Metropolitan Public Garden, Boulevard, and Playground Association. 1884.

We have here the report of a Society which in an unobtrusive way is effecting a good work. We fully admit the general truthfulness of the sad picture here drawn of the condition of a large part of the metropolitan population. The question, what can be done to reduce the "din and uproar,"—"the whirl and hurry, slavery and closeness," among which the majority of Londoners live and die, is becoming more and more pressing. Among the various agencies operating in the right direction the formation of public gardens, parks, and playgrounds wherever practicable is not one of the least valuable. Every increase to the small stock of what is beautiful amidst the general squalor and ugliness of this overgrown city must have, as far as it goes, a humanising influence, especially upon the young. The public may be congratulated on the passing of an Act which prohibits the erection of buildings upon disused burial grounds. This measure, by depriving such land of all value to the building speculator, renders its acquisition for the formation of public gardens easier. We may, however, regret the squeamishness which dictated the clause forbidding the playing of games in such grounds.

The Association seems to have been very fairly successful in its operations. As a rule local authorities, landowners, incumbents of churches, &c., have shown themselves desirous of aiding the work of the Association. Occasionally, however, their proposals have been declined. Two instances are given of vestries which at first received the subject favourably, but at the last moment suddenly and unaccountably changed their minds. Two of the City Companies have rejected the scheme for throwing open certain plots of land, and certain boards of trustees have adopted a similar policy.

We venture here to suggest that the Association should, if possible, endeavour to secure for the public that portion of the Alexandra Park known as "The Grove," containing trees which are simply magnificent, and if destroyed, could never be replaced. Should the ground ever be sold, as is not unlikely, these trees will assuredly be hacked down by some wretched building-speculator, and their lovely site will be desecrated by the erection of gingerbread villas, replete with every kind of modern bad taste.

In conclusion we must beg to point to one circumstance which may have its weight with individuals and public bodies who decline to accept the proposals of the Association. Agitation has been set on foot in various districts for rescinding the salutary provision that the public parks, such as Battersea, Victoria, Finsbury, &c., shall not be used for "public meetings." It is certainly intolerable that grounds provided for the recreation of the whole public should be liable at any moment to be seized upon by the most turbulent portion of the population for gatherings which, whatever the intention of their promoters, never fail to draw together the criminal and semi-criminal classes. We believe that if some absolute security against this movement could be obtained, the Association would find its funds increased, and would rarely, very rarely indeed, meet with refusal or even hesitation on the part of persons interested.

The Agnostic: a Monthly Journal of Liberal Thought. Vol. I. Nos. 1 and 2. London: H. Cattell and Co.

In this new journal we find matter differing greatly both in its tendencies, and as it appears to us, in its value also. We first notice on the very title-page the expression "liberal thought," and on futher examination we meet with such phrases as "the liberal public,"—"the liberal movement,"—a "Religious Liberalism," &c. Now we submit that the terms thus used stand in some need of being sharply defined. What is "liberal" thought, and how does it differ from thought which is non-liberal, or which is anti-liberal? Precision is here all the more needed since the word liberal has been adopted as the badge of a political party.

But to the matter before us. G. M. McC. contributes two subtle and thoughtful papers on the "Confession of Agnosticism." In the former of these he contends that "here and now" there are undoubtedly two worlds, to the confusion of popular Secularism. The Secular philosophy he pronounces "a part of the truth, but not the whole." In the second essay he strives to clear away certain misconceptions. He protests against "the utter emptiness of our present labelling systems." With equal force and truth he writes:—"The question of the modern Athenian is not what is the new thing of the day? but, what is it called? And the verdict he delivers depends upon the name—that is the stamp or label affixed to the novelty—and not upon the reality itself, the inward part or thing signified."

True, but not novelties only. We are ruled by catch-words.

But surely now we begin to see that in the organic world species melts gradually into species, we might apply this great truth to our classifications of men.

"An Exposition of Herbert Spencer's Philosophy," by Ignotus, has the very valuable feature of presenting in parallel columns the leading propositions of the Synthetic Philosophy, and of Positivism. How the latter can in these days find any acceptance at all is to us a most painful riddle.

Dr. W. B. Carpenter, in a reply to Captain W. B. McTaggart, sets forth the intellectual basis of his own (peculiar) Theistic belief, and seems greatly scandalised at the gallant Captain's slightly irreverent rejoinder.

The two papers, by Julian, on "The Popular Religious Faith," lie most distinctly outside our competence.

"Man: Whence and Whither?" is considered in two papers by Dr. H. J. Hardwicke. The learned doctor is most emphatically right in denying that the faculty of speech in man forms an absolute boundary line between him and the lower animals. How could the dog possibly understand human language unless capable of receiving from his companions very definite information through the medium of sound?

We may, however, raise a doubt when we are told of the chimpanzee and gorilla families of Africa "walking on their hind-legs only."

The submerged continent of "Lemuria" has, indeed, been denied by high authorities, but almost in the same breath is admitted the probable existence of several large islands, stretching north-eastwards towards Ceylon and Sumatra.

The ability manifest in most of the articles which have hitherto appeared in the "Agnostic" is indisputable. The question may, however, arise, how far will it be possible to prolong the discussion of Agnosticism and its applications?

Magneto- and Dynamo-Electric Machines, with a Decription of Electric Accumulators. From the German of Glaser de Cew. By F. Krohn, and especially edited, with many additions, by Paget Higgs, LL.D., D.Sc. London: Symons and Co.

Works relating to electricity and its practical applications appear to be increasing at a rate similar to that which has until lately been the case with chemical manuals. The difficulty will soon be to decide what special advantage or superiority one work of this kind presents as compared with another.

The author,—or authors,—of the present treatise set out with a history of the development of magneto- and dynamo-electric "generators," a word which is gradually becoming naturalised in England. They then discuss the machines for direct and indirect currents and the peculiar uses and applications of each kind. They next explain automatic switches and the regulation of currents.

We are then introduced to the question of electrical storage, with especial notice of the accumulators of Planté, Faure, and others. We must plead guilty of an especial veneration for accumulators. For do they not fully typify the man of the time,—the student who has prepared for and duly passed his examinations, and is now prepared to let out what has been instilled into him *minus* a certain inevitable percentage of loss?

The sixth and seventh chapters deal with the physical laws bearing on generators and the construction of their several parts.

In the notice of the employment of the machines in question for the production of electric lights we find an explanation in detail of the advantages of large generators.

The last chapter of the work treats of the use of electricity as supplied by these machines for plating, gilding, nickeling, &c., for purifying metals and preparing ozone, and for melting the most refractory metals.

The author concludes the body of the work with an anticipation of the time when energy will be transmitted in the form of electric currents to all the houses of a town, there to be transformed at pleasure into heat, light, or motive power. We may rest assured that so long as the present state of the law continues, this picture will not be realised in Britain.

Four supplementary chapters then follow, giving formulæ for the construction of electro-magnets, describing instruments for measurement, and the latest constructions of generators. Finally, we have the complete mathematical theory of magneto- and dynamo-electric machines as developed by Clausius.

Smoke Abatement. Report of Council of the National Smoke Abatement Institution, submitted at the Ordinary General Meeting Dec. 22nd, 1884. Offices of the Institution: 74, Margaret Street, W.

THE most striking feature in this pamphlet is the expression of a desire that the smoke-prevention Acts should at no distant date be so modified as to entend to dwelling-houses. We fail to see how any such measure could be put in force without inflicting great hardships upon the householder, who already sees his local burdens continually increasing, and his income at the same time diminishing. Between a factory and a dwelling-house there are certain capital distinctions which smoke abators do not duly take into consideration. A factory, if not the freehold of its occupier, is generally held on a long lease. Hence he can fairly be called upon to undertake improvements, and he may, with some show of reason, be told that the reduced consumption of fuel will compensate him, before the expiry of his lease, for the outlay incurred.

With dwelling-houses all this is different. In a vast majority of cases they are occupied by monthly, quarterly, or yearly tenants who have no permanent interest in them, and whose term of occupancy will not—except where they are combined with shops or warehouses—exceed three years. Now to call upon such persons to expend a considerable sum of money in structural alterations when they may, perhaps, at the next rent-day give or receive notice to quit, might surely be called a harsh proceeding.

Any one who knows the British workman of the present day will not, we are sure, consider £2 as too high an estimate for the alteration of a simple fire-grate so as to be smoke-consuming. To subject a man to incessant prosecutions and fines because he has not the means for making these alterations would be deservedly unpopular. Perhaps smoke abaters may say, let the landlord undertake the change required. If so he would certainly charge a most usurious interest on his outlay. Where, again, is the guarantee that the new stoves introduced would be efficient, and if they failed to give satisfaction who would be held responsible?

Further, smoke consumption or smoke prevention will always remain unsatisfactory without we can largely diminish the quantity of coal consumed. For the injury to vegetation, and to objects of stone or metal exposed to the air, depends mainly on the sulphur present in the coal, and which, during burning, is converted into sulphurous acid. Now this sulphurous acid is not in the least diminished by getting rid of all the visible portions of smoke.

From these considerations, and also because we know something about Royal Commissions, we are not sorry that the present Government is "not disposed to grant the application for a Royal Commission" to investigate the smoke nuisance.

It must not be inferred from what we have just said that we are indifferent to the evils of smoke. Although we consider it a mere molehill in comparison with certain other factors which promote national debility, we heartily wish its abolition, though we hold that this "reform," like many others, may be purchased too dearly.

We fully agree with the proposals brought forward at the end of this report, *viz.*, that the boundaries within which the Metropolitan Smoke Act of 1853 holds good should be extended, and that its provisions should be more fully and firmly applied "to steam-boats, locomotives, &c." We should also urge the total prohibition of ballast-burning within the boundaries above-mentioned. We should like to see German stoves, of glazed stone-ware tiles, introduced in all houses hereafter built or rebuilt. By this step we should reduce the consumption of coal and the production of smoke by 75 per cent, and give the London coal-ring its death blow.

Our Corner. A Monthly Magazine of Fiction, Poetry, Politics, Science, Art, Literature. Vol. V., Nos. 1 and 2. January and February, 1885.

"A Southern Shell," by Mr. W. Mawer, is a pleasing study of certain mollusks.

As a continuation of "Our Household Pests" comes a chapter on the Spider, which, by the way, has but doubtful claims to rank as a pest. We do not, like the author, "really feel conscious of a kind of revengeful sentiment upon seeing a spider pounce eagerly upon a struggling fly, gnat, or other dipteron." We are too glad of any aid in thinning those *colporteurs* of infection and pollution, the two-winged flies. But if Madame Arachne entraps a bee, a butterfly, or a beetle, we draw a distinction, and think that the strong-minded lady is acting in excess of her rights. But useful as spiders are, they are scarcely to be loved. When shall we know the nature of their poison?

The same author next discusses the cockroach, which is beyond all contradiction a "household pest." The author points out with perfect accuracy the characters, morphological and embryological, which prove that the cockroach is not a beetle. But he will only lose his labour.

Why is it, we often ask, that foreign weeds and foreign vermin easily get acclimatised in any country, whilst harmless, beautiful, or useful species scarcely ever become truly naturalised? The cockroach and the bed-bug, both aliens, have made themselves quite at home in Britain. But all attempts to introduce *Carabus auratus* (*Le jardinier*) and *Calosoma sycophanta* have failed. Both these insects are useful to the farmer and the gardener, both are beautiful, and both are fairly common on the Continent. Nay, why is it that in spite of all our exertions the foulest weeds hold their ground in our midst, while botanists in all parts of the kingdom lament that lovely plants, such as many of the ferns, are verging on extirpation?

We sympathise with the question raised under "Science Corner":—"When will the resources of Science be used only for the preservation, not for the destruction, of life? Men, not content with murdering each other on the surface of the ground, hope soon to grapple with each other in the air and to struggle beneath the waves?" When, ndeed?

Our Corner. No. 3. March, 1885.

In the current number of this somewhat heterodox journal we find some very interesting matter.

In the account of the trial of Mr. C. Bradlaugh and Mrs. A. Besant, for selling the "Fruits of Philosophy," we are told that Dr. W. Carpenter "rudely said that he was not responsible for 'Human Physiology by Dr. Carpenter,' as his responsibility had ceased with the fifth edition." It seems to us that the learned doctor's position is scarcely justifiable. In the paper before us it is, not unnaturally, pronounced "a strange thing that a man of eminence, presumably a man of honour, should disavow all responsibility for a book which bears his name on the title-page. Clearly, if the 'Human Physiology' is not Dr. Carpenter's, the public is grossly deceived by the pretence that it is, and if, as Dr. Carpenter says, the whole responsibility rests on Dr. Power, then that gentleman should have the whole credit of that very useful book. It is not right that Dr. Carpenter should have all the glory, and Dr. Power all the annoyance, resulting from the work," which it appears is given to young boys and girls as a prize in Government examinations.

It appears that it was the intention of the defendants in this trial to subpœna Charles Darwin. He wrote to them, however, stating that in his opinion "over-multiplication was useful, since it caused a struggle for existence in which only the strongest and the ablest survived."

We need scarcely say that on this point, as on certain others, we disagree with Darwin. We doubt whether those who survive the struggle, in the present organisation of society, are "the strongest and the ablest," or rather those who are not completely dominated by greed. It is practically certain that though a struggle for existence may, up to a certain point, have beneficial effects, yet, just as is the case with heat, light, or moisture, when too much intensified, it becomes destructive.

Mr. Monoure Conway, in criticising O. Wendell Holmes's "Life of Emerson," remarks that "in estimating the relation of Emerson to Science he seems to have hardly done him full justice." Certain lines of Emerson, printed in 1849, are pronounced to have anticipated the discovery of Darwin by ten years. It is suggested that "probably" a lecture on the

"Relation of Man to the Globe," delivered by Emerson as far back as 1833, "will be found to contain a theory of Evolution similar to that popularised eleven years later." But the merit of Darwin lies not in his having been the first to suggest the idea of Organic Evolution, which he certainly was not, but in his working the subject out and placing it on a definite foundation.

Mr. Alexander Dunbar, in an article entitled "The Wages of Unrighteousness," makes the singular remark that "it would be well if all a clergyman's spare time were spent in knocking balls about and worrying dumb animals." We always feel a grudge against anyone who uses the cant expression "dumb animals." The majority of vertebrates and arthropods are not "dumb" in any rational sense of the word, and, in ninety-nine cases out of a hundred, if an animal is truthfully designated as "dumb," its dumbness is quite irrelevant.

Elsewhere the same writer remarks, very justly, "There is so much to be done in every department of human knowledge which is not profitable that it seems almost a duty for anyone with means and leisure to take up some work of the sort. There is probably not a country parish in England in which a diligent naturalist might not make useful observations." But unfortunately the tendency of the age is more and more to prevent anyone from having both means and leisure.

"Evolution as its own End" is not, we think, a memoir of the kind which most readers would expect from its title.

In an address delivered, or supposed to have been delivered, by a condemned criminal in France, we find some significant passages. Concerning the apprenticeship system, the only gateway at present to a practical acquaintance with any mechanical trade, he says—"Labour! don't believe it. The apprentice is the common fag; he goes on errands; he endures curses and kicks from the older men, but he *works* little or not at all;" and again, Society "knows that the atmosphere of the workshop, morally and physically, is injurious to the very young and the untrained, and it permits them to be sent into those dens which seem made to corrupt the mind and debilitate the body." Who, after reading such confessions, will not congratulate himself on being under the industrial *régime*, lauded by the modern apostle Comte and by others? It is to be noted, further, that the criminal says—"My father was a drunkard, my mother a hysterical epileptic." Could Society by any means train the offspring of such parents to be other than a curse?

The Fern Portfolio. By F. G. HEATH. London: Society for Promoting Christian Knowledge.

THIS is, we believe, a publication unique in its kind. All the species of British Ferns are here not merely described, but faithfully depicted in coloured plates, 16 by 12 inches in size. An entire frond in life-size is given in every case but two, the Royal Osmond and the Bracken, which are too large. These plates are exquisitely accurate, and therefore, to the loving eye of the naturalist, perfectly beautiful. The venation, even of the smallest parts, is carefully reproduced. The highest praise is due to the author for the enthusiasm, the devotion, and the patience which have been expended on his task, and we are glad to have the opportunity of congratulating him on the success which he has achieved.

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

"DUMB ANIMALS."

CAN you or any of your correspondents inform me when the cant expression "dumb animals," for all animals save man, originated, and who was its author? In the sense in which it is used in England it is, I believe, unknown in other civilised countries. To the best of my knowledge if a German were to mention "die stummen Thiere" he would be understood to mean merely those animals which are incapable of communicating with their like by sound.

GRADUATE.

[We believe the phrase is a survival. The ancient Greeks called all aliens "dumb." It is now chiefly used by Bestiarians who conceive that it adds weight to their utterances.—ED. J. S.]

NOTES.

Mr. Charles C. Cattell, the Secretary of the Darwin Institute, Birmingham, persists in insinuating that Mr. Darwin was atheistically inclined. In an address on "Charles Darwin, and what led to and sustains his Theory" (undated, but evidently recently published), this writer admirably arrays certain of Mr. Darwin's manifold indictments of the doctrine of design, and remarks that "In his first work, when under the influence of the old idea, he only attributed to the Creator the origination of life, and assumed the existence of only a few original forms, perhaps four or five." Mr. Cattell is perhaps unaware that in the second edition, revised, of the "Variation under Domestication" (1875), Mr. Darwin implied a continuance of belief in this doctrine (*vide* p. 12, vol. i.). Similar movements on the part of the Secretary of the Darwin Institute have been noted in this Journal for August and December of last year (pp. 490 to 492, and p. 729).

Mr. E. Gilpin, F.G.S., in a paper read before the Geological Section of the British Association, anticipates a permanent and profitable future for the gold-mines of Nova Scotia.

M. H. Beauregard ("Comptes Rendus") studies the digestive apparatus of the Cantharidæ. Its three portions—the œsophagus, the stomach, and the intestine—are divided by two valves placed at the anterior and posterior extremities of the stomach. The anterior valve offers three types, occurring respectively in *Epicauta* and *Lytta*, in *Cantharis* and *Mylabris*, and in *Meloe*.

Prof. Plateau concludes, from a series of experiments, that the contractile force of the muscular fibre is not the same in all animals.

Gerhard Krüss ("Berlin Berichte") calls attention to the influence of temperature in spectroscopic observations. By an increase of temperature all phenomena of absorption and emission are removed towards the violet end of the spectrum if glass prisms are employed, and towards the red end in case of quartz prisms. These displacements are generally greater when they occur in the more refrangible regions of the spectrum.

"Science" complains of the neglect of the entomological collections in American museums. We fear that such carelessness is not confined merely to America.

Dr. E. B. Tylor remarks that the moment that anthropologists take to cultivating their science as a party weapon in religion and politics, this will vitiate their reasonings and spoil the scientific character of their work.

Dr. Harrison ("Canada Lancet") records the strange fact of a sick child voiding a large number of the pupæ of the Colorado beetle. The insects did not seem the worse for their abnormal sojourn.

Liquefied carbonic acid is spoken of among German engineers as "the power of the future."

Mr. Ruskin justly complains that "the whole force of education until very lately has been devoted in every way to the destruction of the love of Nature. The only knowledge which has been considered essential is that of words, and next of abstractions."

According to a contemporary, in an examination on physiology some years ago, at South Kensington, the question was put, "What is bile, and what are its uses?" One candidate's answer was "Bile is formed in the stomach, and is used for cleaning carpets."

Mr. Cope Whitehouse maintains, in "Van Nostrand's Engineering Magazine," that the artificial Lake Mœris must have had the dimensions ascribed to it by Herodotus and Ptolemy, and that the Pyramids, including that of Cheops, were formed from the rocks cut away, the stones being not raised up, but let down to their present positions.

We cannot adequately express our regret at finding that Mr. A. R. Wallace has descended into the region of politics.

"Light" writes:—"Now we protest emphatically against any attempt to suppress the search after truth, in whatever realm, natural or supernatural, by an appeal to the strong [better 'blundering'] arm of the law." Surely a denunciation of the Anti-Vivisection Act, as well as of the "Slade prosecution."

A writer in the "Popular Science Monthly" complains that an education in Germany fills a youth "with a love of research for its own sake, not for the sake of its direct bearing upon practical results." Precisely so; and without this love neither man nor nation will ever become great in Science.

Dr. F. Müller shows that the excrement of Carnivora, fed upon pure flesh, is essentially a secretion from the intestinal canal, and not a residuum from the food ingested.

M. Pasteur proposes, as an interesting series of experiments, to feed young animals from their birth exclusively upon *pure* nutritive matter,—*i.e.*, such as has been artificially and completely deprived of microbia.

M. A. Villiers ("Comptes Rendus") is studying the formation of ptomaines in the animal organism, during certain diseases.

Mr. W. S. Green has discovered the Alpine Edelweiss growing on the high mountains of New Zealand.

Military and political spies in Asia and Africa now pose as geographical and zoological explorers, and mask their real aims beneath the wings of 17,000 specimens of Lepidoptera.

The total proportion of phosphorus in the brain of a horse is, according to Dr. Baumstark, 0·347 per cent, or, if calculated on the dry matter, 1·297 per cent.

Says a writer in "Science,"—"The time may come when it will be not unusual to study 'veridical phantasms' by polarised light, and to observe their behaviour in a magnetic field."

M. Faye ("Comptes Rendus") notes that sun-spots proceed rapidly from the minimum to the maximum, and they decline slowly towards the next minimum. The same is the case with almost all the fixed stars.

E. Dönhoff ("Archiv. für Anatomie und Physiologie" has discovered in the intestine of the larva of the "wax moth" (*Galleria cereana?*) a special ferment capable of decomposing wax.

P. Baumstark (("Zeitschrift f. Physiologische Chemie" has succeeded in establishing the presence of protagon in the brain as a definite compound.

It is noticed in the "Zeitschrift für Analytische Chemie" (xxiv., p. 135) that bees perish if fed upon glucose.

According to the researches instituted by J. Förster ("Archiv. für Hygiene") borax is an objectionable ingredient in human food, as interfering with the utilisation of some of its constituents and increasing the secretion of mucus in the intestinal canal.

From observations made in France the phenomena of vegetable life are retarded by a mean of four days for each additional 100 metres of altitude. The arrival of the chimney swallow is delayed by two days for each 100 metres.

Mr. R. Brudenell Carter, in a lecture on the influence of civilisation upon eyesight, remarked that he had offered the London School Board to examine the eyes of the school-children, but his offer "was declined in an uncivil letter, written in very bad English."

Mr. Atkins ("British Pharm. Confer."), when at Vevey, was told by a large vine-grower that the grapes of one field, which had the afternoon sun, produced a wine of a much higher quality than the vines which had the morning sun.

The Dutch Society of Sciences, at Harlem, offers prizes for new researches on the quantity of heat radiating from stars of the first, and if possible of the second, magnitude, having regard to the heat absorbed by the atmosphere and by the lenses; also for an examination of the results hitherto reached in the study of the specific volume of liquids or solids; also for new observations and experiments on the pathological phenomena occasioned in man and other animals by certain bacteria; also for a precise study of the history of the development of some species of Annelida; also for a study of the means applied or proposed for determining the influence of the ironwork of ships upon the compass, and for the complete or partial elimination of this influence. Memoirs in reply to these questions, each accompanied by a sealed letter containing the author's name, must be sent to the Secretary of the Society before January 1st, 1885. The memoirs may be written in Dutch, French, Latin, English, Italian, or German, but not in the German characters—a very prudent reservation.

☞ Professors Morgen and König ("Landwirth Versuchs. Stat.") find, experimentally, that an addition of 10 per cent of kainite to decomposing horn-powder entirely prevents the loss of nitrogen.

"Science" proposes to utilise the Yellowstone Park as a bison preserve. This animal appears to be much nearer extermination than it has been commonly supposed.

In some countries there prevails an opinion that to secure eggs during incubation from the injurious action of thunderstorms, a piece of iron ought to be placed beneath the nest.

According to "Cosmos les Mondes" a long-haired elephant, larger and more perfect than any specimen hitherto secured, is being extricated from the ice at the mouth of the Lena.

According to Nencki and Sieber ("Berlin Berichte") the hæmine crystals of different animals appear to be identical. The hæmoglobine crystals of different species are, on the contrary, distinct. The hæmoglobine of ox-blood is hygroscopic and deliquescent; that of the raven is sparingly soluble in water. Most hæmoglobines crystallise in the rhombic system, but that of the squirrel in the hexagonal. The authors ascribe these differences to the fact that in different species one and the same colouring-matter (hæmine) is combined with different proportions of an albumenoid, or with different varieties of albumenoids.

According to "Ciel et Terre" tanners predict rain when the liquid in their tan-pits rises to a higher level.

Dr. J. Seegen ("Biolog. Central Blatt") sums up his results on the formation of sugar as follows: they confirm the conclusion that sugar, in a normal constituent of the blood, ranges in dogs from 0·1 to 0·15 per cent. The blood on leaving the liver contains twice as much sugar as that entering the organ. In three animals, weighing respectively 7, 10, and 41 kilos., the quantities of blood issuing from the liver in twenty-four hours were 179, 233, and 423 litres. Consequently 179, 233, and 423 grms. of sugar were daily introduced into the circulation. In the Carnivora this sugar is formed from the albumenoids of the food consumed, the greater part of the carbon ingested being utilised in the formation of sugar. The formation of sugar and its transformation in the blood rank among the chief functions of the mutation of matter.

Miss Adele Fielde confirms the experimental conclusion of Dr. Karl Bülow, that earthworms are able to regenerate portions of lost tissue.

According to "Ciel et Terre" the mean weight of dew deposited nightly is 130 grms. per square metre.

If the water-supply of towns is to be kept wholesome it should be guarded from the access of dogs, as their excreta are the great means of diffusing hydatid disease.

M. Dieulefait, in a communication to the Academy of Sciences, showed that the ash of plants still surviving from the Carboniferous Epoch, especially the Equisetaceæ, growing on the most different soils, contain proportions of sulphuric acid greatly in excess of the quantity found in the ash of plants of the present epoch. This accounts for the presence of large quantities of sulphur and calcium sulphate in all coals.

Professor Carnelley is applying the periodic law in mineralogy.

Mr. H. Carvill Lewis (Philadelphia Academy of Natural Sciences) has observed an interesting case of phosphorescent snow. A mountain covered with this snow shone by night as if illuminated by the moon.

The "Popular Science Monthly," discussing the physical training of girls, pronounces the piano the "domestic vampire."

A Spiritualist writer declares his conviction that even the tapeworm has some important duty to execute.

It is said that 16 per cent of our native blue flowers bloom in April, 14 of the white, 9 of the red, and of the yellow about the same as the red. Some regard this as an inverse spectral order.

According to Dr. Ihreng ("Kosmos") polydactylous horses, with extra toes on the inner side of the fore feet, are occasionally met with in South America. He raises the question whether these are not survivals of an old race of *Equus* which escaped the notice of the Spanish settlers?

"Cosmos les Mondes," which is not the better for the death of its former distinguished editor, the Abbé Moigno, describes itself as in favour of Evolution, not indeed according to Darwin, but to Claude Bernard,—that is, upon a definite plan.

Mr. C. H. Hitchcock ("Science") gives, on the authority of Mr. Leitch, formerly a missionary in Ceylon, a case of a serpent about 7 feet long,—name not given,—which, when being killed, made a loud noise like the bellowing of a bull two years old.

A "prayer meeting" in defence of the vested rights of syphilis has lately been held in Exeter Hall.

M. Sivodot has been elected a "Correspondent" of the French Academy of Sciences in place of the late C. Darwin!

The forests of the United States are composed of 412 species of trees, assignable to 158 genera; 48 of the genera and 60 of the species are peculiar to Florida.

Herr Von Gossler, the German Minister for Education, has issued a series of regulations for experiments upon living animals. These regulations are infinitely wiser than our British Anti-Vivisection Act, but they may be pronounced weak in conceding anything to the Bestiarians. The worst point is that experiments on animals can be conducted only by professors and college-*docenten*, thus shutting out private biologists.

"Light" considers that the witches put to death two centuries ago were in many cases mediums of mischievous human spirits.

"Light" is seemingly not well pleased with our question, anent the Premier's visit to Mr. Eglinton, whether Spiritualism would take up a political character? We submit that it is nothing new for party-leaders to bid for the good will of any body of men which is gaining influence. We should be sorry to see Spiritualism follow the example of Positivism, Secularism, &c., by associating itself with any political party.

"A ghost" may possibly be a four-dimensional being, but, if we admit the existence of four-dimensional space, we may ask whether there may not be material beings who exist and act in such space?

Mr. T. B. Comstock ("Science") seems to include the grizzly bear among the animals to be preserved in the Yellowstone Park.

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THE JOURNAL OF SCIENCE.

APRIL, 1885.

I. COMET SYSTEMS.

By J. R. SUTTON.

"WHEN," says Guillemin, in his magnificent work 'The World of Comets,' "in accordance with the facts of Science, we endeavour to form an idea of the constitution of the visible universe, we see that the celestial bodies which compose this whole are everywhere distributed into groups and associations united by the common bond of universal gravitation.

"There are the *planetary systems*. In the centre of each group is a star or central sun whose preponderating mass retains near him, circulating in regular orbits, other stars or planets, to which the central sun distributes heat and light. Our planetary system is the type of associations of this kind.

"There are the *stellar systems:* groups of two, three, or more suns gravitating about one another, probably in accordance with the same laws.

"In certain regions of the heavens the nebulæ are themselves to all appearance grouped into systems, so that the general plan of the universe is one vast synthesis of associations of different orders encompassing each other without end. Nor can any individual star escape the necessity of forming a part of one of these groups.

"Are these likewise *systems of comets ?*"

In answer to this query M. Guillemin gives a *resumé* of the results which followed upon the labours of Hock, a

Dutch astronomer of repute. These results seem to indicate that many comets do travel in systems, even as do the tiny meteors which circulate in common orbits around the Sun. The following table exhibits a specimen of one of these systems, showing the relative distances, at different times, with respect to the Sun, of the comets which compose it. This, also, I quote from the above-mentioned work.

Distances from the Sun in Radii of the Earth's Orbit.

Date.	Comet 1860, III.	1863, I.	1863, VI.
757·0	600	600·4	600·2
1020·9	500	500·6	500·4
1259·6	400	400·7	400·5
1470·0	300	300·9	300·8
1647·8	200	201·1	201·2
1785·1	100	101·8	102·1
1833·7	50	52·8	53·3
1853·6	20	24·4	25·5
1858·0	10	15·9	17·4

By this table it will be seen that whilst the three comets whose positions are here shown were in 1858 situated respectively at a distance of 10, 15·9, and 17·4 radii of the Earth's orbit from the Sun, they were in the year 757—or 1100 years ago—at very nearly equal distances from the ruling centre of the Solar System. Moreover, their paths are directed towards an identical portion of the celestial sphere, and, besides, their orbits differ but little from each other, being appreciably parabolic.

Now these facts are sufficiently surprising: they seem to show beyond doubt that these three comets are related and of common origin. Furthermore, the same remark will apply to several other cases, including not only the transitory visitors (as these may be) from interstellar space, but also several others which belong to the Sun's family.

But it appears to me that the conclusions founded upon the labours of the Dutch astronomer are somewhat far-fetched. Thus, we are told, almost it would seem as though the fact depended upon comets moving in systems, that "every star is associated with a cometary system *of its own*" (the italics are mine); "but owing to the attraction of planetary or other matter these bodies continually leave their proper primaries, and revolve either permanently in ellipses, or temporarily in parabolas or hyperbolas, round other suns."

Why, now, should this conclusion be a resultant from the fact that some comets appear to be associated? Surely it does not follow with more certainty that because *three* comets are travelling in company from the region near any one star, that they emanate from that star, any more than it would follow that a single, solitary comet belonged originally to the domain of any star because it happened to be travelling away from it. Far be it from me to cast a slur upon the useful work which M. Hock has accomplished; but, so far as is given me to judge, it is quite certain that he leaves the question of the *origin* of comets, from whence they come and whither they go, very much as it was found. And, further than this, the table given above shows that somewhere near the year 750 the three comets we are discussing were at their nearest to each other; for if their motions be calculated backwards *beyond* 750 indefinitely, it will be found that all three are placed further and further apart the earlier the date to which we push our calculations. Thus the comet III., 1860, which was in that year less than half the distance of either of the other two from the Sun, would, if our inquiry be carried backwards sufficiently beyond 750, be found at a distance greatly in excess of the others, in consequence of its much more rapid rate of motion. The three, therefore, could never have started simultaneously upon their journey, as M. Guillemin seems to suppose, unless as a single comet; and in this case it is clearly discernible that not any more significance attaches itself to their movements than to the movements of a comet which retains its entirety. Nor is it conceivable that any star could so launch forth into space three separate bodies, at different times, that their common direction of motion should point towards the Sun. Still more impossible of conception is it that their separate velocities should be so adroitly imparted that all three were caused to join company at one time (some thousands of years after the commencement of their journey, probably), and in one spot.

Does it not seem more likely, then, that all three are the remains of a shattered comet? We know that comets have broken up almost under the very eyes of astronomers, and there is every reason to suppose that a similar catastrophe has happened in this case. Ephorus, the Greek historian, mentions that the comet of 371 B.C. divided into two; Kepler likewise speaks of the possible duplication of a comet which he observed, and got well ridiculed for his pains!

But in our own time a phenomenon precisely similar has occurred, the circumstances of which are briefly as follow: —On February 27th, 1826, a comet was discovered by Biela at Johannisberg, and was afterwards found to travel in an orbit of 6¾ years' duration. Since then it has, with only one exception, been observed at every approach to the Sun, up to the year 1846, in which year it split up into two distinct parts. Both of these receded from each other until the middle of February, when they were separated by an interval of 190,000 miles. After this time they approached somewhat, so that when they reached the limits of our scrutiny the distance between them barely exceeded 170,000 miles or thereabouts. In 1852 (their last observed appearance), however, they were found to have travelled asunder considerably during their period of invisibility, the distance having increased to 1,500,000 miles. And in short they may now, if still existing, be regarded as totally distinct bodies.

Now if phenomena such as this are possible, is it not also possible that the three comets mentioned above were generated similarly? For what is to prevent Biela's comet, or any other, from dividing yet again? In fact, for all we know to the contrary, a comet may carry on the process of duplication until, for want of bulk, a further division is no longer possible. Analogy would lead us to infer, if such is the case, that this triple system of Hock started into existence, as a system, in or near the year 750, at a distance of—in round numbers—57,000,000,000 miles from the Sun. Hence if this explanation be admitted—and it is obviously more probable than the other—it is clear that the mere fact of the existence of a system of comets teaches us nothing respecting the *birthplace* of these "vagabonds" of interstellar space.

Another point needs to be noted. The three comets referred to are travelling, as I have said, in orbits appreciably parabolic. Now nothing but a combination of most favourable circumstances would enable a comet to describe a strictly parabolic orbit round any star. For let us suppose it to be travelling alone with any velocity before it arrived under the influence of any foreign sun. Then this velocity it would never lose, unless by accident; and the velocity imported by its ruler for the time being would be additional, and, after a time, terminable. For no sun can command a velocity greater than it can generate: thus, since the comet would always retain its own native velocity in addition to that enforced by any extraneous power, the two velocities combined would supply the speed necessary to carry it back to the space from whence it came. Hence in this case the orbit would be hyperbolic. A true parabola, however, requires such a nice adjustment that the least disturbance may transform it into an ellipse or hyperbola.

Now comets with hyperbolic orbits acknowledge neither permanent rule nor governance. They come down into our system with such a rush that the swiftly moving planets seem reduced to rest in comparison; but after their perihelion swoop they, in all cases, return to wander alone in space. Nevertheless it seems certain that comets are certainly captives from the realms of space. One theory, and one only, which regards comets as originating within the limits of the Solar System, is worthy of discussion,—the theory, namely, that comets are disgorged from the planetary volcanoes or erupted from the Sun. Yet even this when examined is found to be defective. For is it probable that Saturn or Jupiter could belch forth matter with a velocity sufficient to carry it in a retrograde direction round the Sun, after the respective manner of the comets of Temple (1866) and Halley? Surely not, since a velocity of projection of 35 miles a second would only just enable a comet to pass clear of Jupiter's attraction! Could the Sun, either, drive matter, such as comets are apparently made of, through his dense atmospheric envelope with a velocity sufficient to carry them for ever beyond his rule? In all possibility, when the depth and density of his elastic covering is taken into account, a velocity of 500 miles per second* would be insufficient! It is safer, then, to conclude that comets are entirely of extra-solar and extra-stellar origin.

But it may occur to the reader that we have just endeavoured to show that a comet advancing with a pre-received velocity into the Sun's domain could not remain as a permanent member of the Sun's family, *unless by accident.* This is just; and previous writers, who have held that comets are originally from without, have, in reply to this very question, formulated very elaborate hypotheses about comets being held in bondage by the Sun in consequence of "the disarrangement of their orbits by planetary influence," and so forth. Now it seems to me that this last supposition also is too imaginary to stand its ground for a single instant. We must, I fancy, go back into the Ages, to a time when the Sun ranked as a nebulous star, if we wish to arrive at the epoch when the Sun's *cortège* of comets were captured and reduced to a fair amount of obedience.

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* This velocity of projection has been observed; it does not follow, however, that the erupted matter was necessarily a comet.

Those of my readers who have read my article in the "Journal of Science" (vol. vii., pp. 33 to 44) will perceive upon what grounds I build up that which follows. The theory running through that article was to the effect that the various suns throughout the universe draw in the loose matter from the surrounding space to feed *in part* their decaying energies. And it must at least be acknowledged that that theory accounted accurately for the observed facts to which I applied it. Hence, since this matter would naturally congregate thickly near the Sun's surfaces, the younger ages of a star must of necessity be nebulous.

Now let us take an imaginary case from the early periods of the Sun's history. We will suppose that a comet is moving towards the Solar System with a velocity supplementary to that which it acquires from the Sun. Then, granting that the nebular or meteoric matter is congregated with sufficient density in the Sun's neighbourhood, the comet will experience a certain amount of retardation in making its perihelion swoop. If, therefore, the retardation thus caused is sufficient to change its orbit from a hyperbola into a closed curve, be it ever so elongated, then will the comet be for ever under the Sun's dominion. With every approach to the Sun the same difficulty will be experienced in making the perihelion passage—though in a less degree each time, because if the orbit takes a great time to describe the Sun will have consumed a considerable quantity of his meteoric supply in the interim—until orbits such as those of the comets of Encke, Faye, &c., are attained.

Speaking incidentally of these last I am reminded that the periodical time of revolution of the former (the nearest of the known comets to the Sun) is constantly diminishing; only, it is true, by a matter of two hours or so on the average of each revolution, yet even this small decrease is sufficient to materially alter the comet's orbit in the course of time. Astronomers have thence concluded that some resisting medium retards the comet's movements, thus giving the Sun greater power to draw it towards himself; and this is probably the correct explanation. Can it be, then, that the meteoric matter which originally caused its capture from the outer space still aggregates near its perihelion? If so, it is pretty clear that it must be of less density than formerly. At any rate it is quite certain that meteoric matter does still exist in vast quantities in the Sun's immediate vicinity.

I have mentioned that comet systems exist both within the Sun's domain and outside. The last of these were, it seems, formed after the manner detailed above; but the former, although they may have been in some cases formed similarly, must obviously have been formed after a somewhat different manner.

Let us inquire into this:—

The orbit of Jupiter is found to be exceedingly rich in cometic aphelions. So thickly, indeed, do they congregate that not in the instance of any other planet in the Solar System is the peculiarity so marked. Now the eruption theory claims that this circumstance is thoroughly confirmatory of the fact that the Jovian comet system had its genesis in the interior of Jupiter's mass. On the other hand, the advocates of the capture theory maintain that the facts prove that comets are captured from space, and brought under the Sun's attraction in consequence of the disturbing action of the larger planets; and certainly of the two the latter seems the more probable, albeit arguments have been recently adduced which entirely weaken its credit. But if comets are enlisted into the Solar System in the manner I have supposed, we can easily see that the mighty Jupiter would possess an influence over the new arrivals greater than that of all the other planets put together. Hence we should expect their aphelions to lie in the vicinity of Jupiter's orbit. And thus would arise the Solar Comet Systems, which could easily, as in the case of Biela's comet, increase the number of its component members by duplication.

Note.—It is necessary, perhaps, to explain more fully those passages in which reference is made to the earlier ages of Solar Systems. To put the matter shortly—How do we know that loose matter is drawn into a planetary system from outer space? In the first place, we can trace a process which is nothing if it is not a graduated series of world development. On every hand we have sure signs that evolution is not confined to animals and vegetables alone. And although we have never yet been able to observe the actual transformation of a nebula into a star system, we have, nevertheless, something which amounts to almost the same thing, when we remember that from the irregular nebulæ to the perfectly formed star, or star system, the gradation of world development is without a break. None of those "missing links" trouble the student of the star-depths as they trouble those enthusiasts who—without being either students of Nature or philosopers—can yet assume (by virtue of their loud voices it would seem) to proclaim from the house-tops the wickedness and the degradation of Darwin and his disciples. And passing from thence to the Milky Way, we perceive there—in almost any spot to which our telescope happens to be pointed—the affinity which quite obviously exists between the large and small orbs which together make up that wonderful zone. Wherever a brilliant star exists, there either is the adjacent space cleared of small stars or these last are clustered in more than average numbers,—both of which circumstances prove an affinity, or else, if we like to close our minds to evidence, a most remarkable concourse of coincidences ; at all events, a fact sufficiently formidable to prove that the distances separating the brighter from the less brilliant orbs is not so great as had previously been supposed. Now except in those branches which *must* here and there extend outwards away from the Earth—for we cannot logically suppose that all the branches from the main stream of the Galaxy are lateral, that is, that they all run in directions square to the visual ray from the Earth—the Milky Way cannot possibly have a greater average depth than it has average breadth. We may, in fact, fairly regard it as a belt. And because nothing leads us to conclude that the most powerful telescopes yet constructed have been powerful enough to thoroughly analyse this belt (every increase of instrumental range showing a greater number of stars), we may safely infer that the number of stars made visible would go on increasing with every further such increase of range. These stars of lesser brilliancy must therefore be actually, as well as apparently, small ; and indeed analogy points to the conclusion that there is not any limit to their smallness, for here, it does appear, have the bulk of the whole of the small bodies (those parents of the larger orbs) from the bounds of the visible universe been collected.

II. ORIGIN OF THE IDEA OF THE BEAUTIFUL.

By D. Y. Cliff.

I WAS particularly struck the other day with this thought as I stood gazing from the heights of Rumble's Moor up the rocky vale of the Wharfe :—Why was it "beautiful" to me? Why should my frame be thrilled and my thoughts elevated? No wonder the old Jews were led to build altars in "high places"! I have been down in the dark galleries of great coal-mines; I have walked street after street of working men's houses; I have gone through great factories, and watched uncouth monsters doing the work of hosts of men; but none of these were beautiful to me, or to any one else either.

It is not "being used to it." It is not because it has a pleasant or objectionable association,—that is, affection, prejudice, bigotry.

The face of one woman is sweet, another is repulsive, even though both are young; these are with us every day, so it is not "a matter of education."

Again, the Black Country, the Rochdale district, &c., have no charm for us; but the Royal Vale of Cheshire, or the woods and fields that line the "swift flowing" Wharfe, —the Bolton of Wordsworth,—these stay our gaze and arouse our better feelings. But they who live amongst these diverse scenes are neither better nor worse than other folks; the appreciation of the beautiful is then no individual life matter.

The explanation of all this is perhaps unromantic to some : there is no other solution to it than Evolution. It is inbred in our nature; it is of a piece with the instincts of birds, &c.; in fact it is a human instinct.

When we know that a healthy colour in the cheeks betokens vitality, vigour, health, strength, &c., and bear in mind that such would be the "fittest" who would "survive" their weaker sisters, is there any longer a doubt why the rosy cheek became beautiful in our eyes?

Such men as mated with weaklings in the old ages would leave no offspring fit to hold their own, so that the red cheek would force itself (certainly through no, or little, choice) into our sense of the beautiful. Those of our fathers who, by caprice, fancy, or otherwise, preferred the healthy woman, naturally propagated their idea downwards. Certainly they did not know what they were doing, and doubtless we are doing a number of things just in the same that we don't know. This instance will apply to every part of the human body, every one of which no doubt has worked itself out from "the best," the fancy becoming an inbred and useful instinct. It stands to reason, then, a taste for a pale face is false, acquired; but no doubt it has a complex reason for it: if it had not, a pale face would be hideous to every eye.

What is hideousness? Merely the negative to our notion of the beautiful? Is it not the unusual, the unfamiliar? our perceptions are afraid of it. An ugly face: is it an unavoidable outcome? Or was it congenial to the general ideas of its parents? Perhaps not to the immediate ones; but, disagreeable though the question is, may it not be "in the race"? There is undoubtedly a reason and a law for all things. The beautiful does not infallibly indicate a similar mind,—often the reverse (though a man or woman's "notion of himself or herself" must leave its impression in their posterity). There must be great complexity; to add a new influence (in the shape of a fresh "cross") is like pouring a new element, not only into one pot, but a host of pots alongside one another, all containing different compounds,—and that new element is itself a compound. The old parts are still *there*, but how different and unrecognisable!

The beautiful is the everlasting, familiar, and useful; whilst the hideous is that which has been rare in the long work of Evolution, and hence, avoided and scorned, the development of the taste for the "local type of beauty" is quite recent to this.

The beautiful in thought is a repetition of that in existence; our brain has become used to its passages. Directly we wander into the regions of pure thought it ceases to be beautiful, and becomes "dry." (The distinction between sensuous thought and thought-thought—so to speak—is a profound subject yet to be solved).

So when I look on the mountains, and love them, it is because they filled the brains of my fathers for æons of ages; and when I peer about the dark caverns that man has excavated, they have no beauty to me, because my fathers knew them not.

Query,—Is one cause of the stunted race of mechanics due to the constant strain on their vitality owing to its exertions in continually accustoming itself to those sights which are racially (so to speak) strange, as yet not ingrafted as "instinct"? (How much power over the health has the mind?)

The artist prefers a ship in sails to the more modern steamboat,—why? Because his fathers have been familiar with the one for generations, and the other is "new," and still has to be imprinted on the brain of man so as to leave its effect on his seed.

III. THE BOLIVIAN MONSTER: TESTIMONY IN SCIENCE.

FROM time to time the naturalist is exercised by rumours, more or less definite, of the occurrence—or even the capture—of some novel or anomalous animal. We do not here intend to speak of *the* sea-serpent, although against the positive evidence for its existence there can be set merely a fact of doubtful value,—*i. e.*, that no large snake-like vertebræ have ever, as far as is known, been washed ashore or dredged up from the depths of the sea. Far less attention has been paid in the outside world to the reports of a gigantic subterranean creature, said to occur in Brazil, and occasionally to displace and uproot trees in its burrowings.

Coming nearer our more immediate subject we may refer to an account which reached us some years ago of the capture, in the interior of Queensland, of a powerful and dangerous Saurian quite distinct from the crocodiles and alligators of modern times, and approaching more closely to certain extinct reptile groups. This animal, we learned, had killed and devoured several "black fellows," and had at last been destroyed after a desperate struggle. The skeleton, we were informed, was on its way to London. Unfortunately it has never arrived.

Now in all the cases just mentioned there is no antecedent improbability. The very name "sea-serpent" has become almost a synonym for a baseless falsehood. Yet since we see that the ocean is the home of mammals, vastly transcending in size the largest terrestrial species, it is at least not impossible that the same rule may hold good for reptiles. The sea-serpent, according to the most liberal statements, only bears the same proportion to the python that the whale does to the elephant.

An earthworm of 6 feet in length has actually been captured in South Africa. A species not greatly superior in size may have been the cause of the probably exaggerated reports of the underground monster of Brazil.

Nor was there in the story of the Queensland saurian any feature which could *à priori* inspire suspicion. It is surely unsafe to say that all animal forms—even of large size—existing in the world have been already captured, described, dissected, and duly deposited for examination in our museums. Nor have we any warrant for at once denying the existence of a species of unusual dimensions. Still less are we justified in sneering at those who would bid us, in such cases, at least to suspend judgment until decisive evidence has been obtained.

There are, however, cases in which incredulity is much more warrantable. Thus some years ago we saw, in a literary and political organ of the *ulcerated* class, as "Punch" once termed them, a figure and description of a "sea-monster" said to have been observed somewhere on the western coast of South America. This creature, whether it had a real existence or whether it had been evolved out of the consciousness of "our own artist," presented the startling feature of three pairs of limbs. We need scarcely say that no vertebrate animal, recent or fossil, has been found possessing more than two pairs.

The Bolivian monster, which is our more immediate subject, displays a characteristic still more improbable. We do not say "impossible," since the use of this word in Science is rarely prudent, accused as *savants* now often are of their liability to the "credulity of scepticism." It may indeed be useful, before proceeding to a description of the animal in question, to justify the reluctance of scientific men to accept human testimony unsupported by evidence of a more palpable kind. This reluctance has, we believe, called forth of late some very strong comments. It has been pronounced singular that evidence such as in any Court of Law would suffice to convict any accused person of murder, should, in the Courts of Science, be dismissed as utterly inconclusive.

On careful reflection, however, an essential difference cannot fail to strike every unprejudiced person : in the cases which come under the notice of Courts of Law,—such as murder, robbery, forgery, incendiarism, and the like,—the question is concerning matters which are, unfortunately, within the range of ordinary human experience. We know that under certain circumstances men have the power and the will to commit murder. Hence the Court has merely to deal with a very simple problem, which may be solved by the consistent testimony of two or more persons of sane mind and unblemished character, provided it appears that they had had the opportunity of observing what really took place.

But let us suppose that two witnesses, unexceptionable in every respect, came forward and swore that a certain person, A. B., being involved in a quarrel with C. D., stepped back and made a strange gesture, whereon the earth immediately opened and swallowed up C. D. : would A. B. be, upon such testimony, condemned to death as a murderer ? We believe the Court would hold that it must first be shown that any man has or can have the power of causing the earth to open when and where he pleases. In default of proof of this nature the sanity or good faith of the witnesses would be called into grave question, and it would be contended that the opening of the earth, if it actually took place, was a mere coincidence, for which the accused was in no way responsible.

The consideration of this supposed case, as contrasted with an ordinary murder with poison, with fire-arms, or with the dagger, will throw light upon the alleged reluctance of scientific men to accept human testimony. They show no reluctance when the phenomenon testified to comes within the scope of ordinary experience. When it does not fall within such scope they naturally demand other evidence. Thus, suppose a traveller, returning from Central Africa, informed the world that he had found a mass of a substance possessing all the chemical and physical attributes of iron, but of so low a specific gravity as to float upon ordinary water, his report would be rejected, and that by men of the world, perhaps, even more emphatically than by men of Science. There is certainly no *à priori* reason why the chemical properties and the physical attributes—save one—of iron might not occur in a substance as light as potassium. But the fact that no one, alike in laboratory or museum, in market or workshop, had met with such iron or iron-like substance, would ensure the rejection of the story except the traveller had brought with him a specimen of the strange metal. Then our conceptions of what is "possible" would have to be re-adjusted.

Or suppose some chemist not known to fame should succeed in decomposing one of the so-called elements, and of transmuting one into another. Here, also, there is no *à priori* impossibility. He would merely have succeeded in doing what many have attempted and are attempting, and what probably all chemists desire to see done. But his report would be received with hesitation until his experiment had succeeded in other hands, or at least had been repeated by himself in the presence of competent judges.

Here, again, our views as to the extent of the possible would have to be enlarged. It might perhaps be well if we had another term to be used in place of "impossible" in all matters of contingent truth. In such cases we want a word to express what lies outside of, and is more or less signally opposed to, general experience. It will, we think, be admitted that the more widely any alleged fact departs from such general experience, the more complete verification it will require.

We may now turn to the account before us of the Bolivian monster. A brief notice of it was forwarded us by a Manchester correspondent,—a gentleman whose well-known intelligence and standing excluded all suspicion of a *canard* or of an intended hoax. His letter was published in our issue for June, 1883 (p. 368), and earned us in certain quarters a few sneers. We now learn further particulars from the "Journal de Luna" and from "Cosmos."

The animal in question was killed in the River Beni, in Bolivia—one of the tributaries of the Madera, and hence indirectly of the Amazons. A photograph was taken of the body, an engraving from which appears in "Cosmos." The skeleton is said to have been conveyed to the city of La Paz, where it is now deposited. The length of the animal, from the head to the extremity of the tail, is given as 12 metres, or, approximately, 40 feet. No other dimensions are given, but the body—judging from the figure before us—is exceedingly massive. The general aspect of the creature is that of an aquatic Saurian. There is the usual armour-clad trunk. There are four powerful legs, terminating in formidable claws, but so short that the belly will scarcely clear the ground. The tail is of the usual Saurian character, very much thicker than is met with in any mammal, but differing from that of the crocodiles by the absence of ridges, and by being compressed not laterally, but vertically towards the tip. But when we turn to the head our ideas of the fitness of things receive a shock. Everyone must have observed that in lizards and crocodiles the neck (if we can admit that one exists at all in the familiar sense of the term) and the head lie in the same plane as the back. In this animal, on the contrary, we see a neck—proportionally as long as that, *e.g.*, of a greyhound—rising upwards nearly at right angles to the back, and supporting a head which presents, externally at least, most of the characters of a mammalian head. It is remarked, in the description accompanying the plate, that the head resembles that of a dog. There is a prominent forehead, such as we find in certain heads of dogs, quite unlike the flattened Saurian type of skull. Above all there are two upright external ears, not unlike those of the fox. The importance of this feature will appear if we reflect that no reptile now living, or as far as we know extinct, possesses an external ear; the only approach in that direction is a fold of skin at the auditory opening in the crocodile. Indeed a projecting external ear is so essentially a mammalian feature that an animal belonging to any other division of the vertebrates thus equipped has to the human mind an uncanny aspect.

The only non-mammalian character shown in the plate lies in the teeth and in the width of the gape. The teeth, as far as can be judged from the figure, offer no distinction of incisors, canines, and molars, but consist of a row of sharp wedges, differing little in size, and all pointing somewhat backwards. The articulation of the jaws is at a point much farther back than in mammals, so that the gape is very wide. The lower jaws form almost a flat plate, and no trace of a tongue is visible. If that organ, however, is formed on the crocodilian type, it will not be apparent on a side view of the head, even when the jaws are open. Still, notwithstanding these anomalous features, if the figure is covered up with paper so as to leave merely the head uncovered, non-specialists—in every trial which we have made—pronounce it to be the head of some ferocious mammal.

Whether there exists hair upon the face, or any part of the body, does not appear either from the figure or the description. We must, however, remember that the existence of hair in reptiles is not unheard of, since a small hairy tortoise has been discovered in China.

So far, therefore, this animal possesses characteristics sufficiently anomalous. What follows, if it does not fully justify complete scepticism as to the alleged nature and the very existence of this animal, makes us crave eagerly for fuller and clearer information. According both to the figure and the description the creature has, in addition to the head already described, two others, placed in a parallel position on each side of the spine, about 12 or 13 feet behind the normal head. These two subsidiary heads, though somewhat smaller, have the same eyes, ears, and jaws as the principal head, and they are both turned forwards.

It is scarcely necessary to say that nothing similar has been observed either among the vertebrates, the arthropods, or any other cephalous class of animals.

We may venture on the assertion that these extra heads are either really existent, or they are a wanton and intentional falsehood. We cannot here conceive the possibility of a mistake or of exaggeration. Supposing for a moment we have here before us the record and the portraiture of an actual fact, we have next to ask—Is this a normal feature of some rare animal species, or have we to do with a monstrosity? Prof. Givelti—whose address unfortunately is not given, or we should have taken the liberty of communicating with him—has examined the animal, and forms the conclusion that the specimen is not a monstrosity, but is a perfectly normal member of a rare species. One circumstance upon which this conclusion is based is that certain earthen vessels, which date back to the time of the Incas, are made in imitation of the form of this animal. Hence it is inferred that in former times this strange Saurian was more common than at present, and by its singularity of form—certainly not by its beauty—attracted the notice of the ancient Peruvian potters.

We cannot here take up the numerous and grave questions, morphological, physiological, embryological, and taxonomic, which the existence of this creature, if verified, is certain to raise. It will be a moot point to decide whether its existence will be harder to account for on the theory of direct individual creation, or on that of development by natural selection: both, as it seems to us, will find the task far from easy.

We may, however, glance at the evidence for the actual existence of the creature before us. The two accounts we have received do not exactly tally. That taken from the Anglo-Brazilian "Times" of March 24th, 1883, says that the Brazilian representative at La Paz had sent home to his Government "photographs of drawings" of an extraordinary Saurian. On the other hand, the "Journal de Luna" says merely that the same official had sent "several photographs" of an extraordinary Saurian. This difference is very serious. If the photographs have been taken directly from the animal they furnish conclusive evidence as to its external structure; but if the photographs have merely been taken from a drawing they may embody merely the invention or the exaggerations and distortions of the artist. We fear that the latter is the case, because the figure before us represents the animal standing on its feet, with its necks erect, and its eyes and jaws open as if ready for combat. We doubt strongly whether any explorer on the Beni would travel provided with the necessary appliances for the instantaneous photographic process. The writer in "Cosmos," who does not give his name, obtained his account from his brother, a missionary in Chili, who had translated it from the original Spanish of the "Journal de Luna." He promises, however, further information as soon as it is obtained.

IV. THE COLOURING-MATTERS OF FLOWERS AND FRUITS.

WHETHER we assert that the colouring principles of flowers and fruits have been evolved by a process of natural selection, or that they have been determined by a direct creative act, we give merely a final cause for their appearance, leaving the efficient cause or causes untouched. Yet to many minds it is assuredly the more interesting to know how, when, and where the various colouring-matters have been formed, and by what mechanism they have been transported to those particular parts of the plant where we find them, leaving its other parts untouched. We almost fear that the popular study of Natural Selection has withdrawn attention from these questions. Naturalists have come to think that if it can but be shown how the development of intense colour in the flower attracts insects and promotes cross-fertilisation, all is explained, and *presto!* the colour must make its appearance.

It is therefore satisfactory to find that Dr. A. Hansen has recently carried out some very important researches on the colouring-matter of flowers. His chief results have been published in the "Verhandlungen der Physik. Med. Gesellschaft zu Würzburg" (vol. xviii.), and in the "Naturforscher."

It appears that a relatively small number of pigments serves for the production of the seemingly endless variety of colour in flowers and fruits. The white and black shades which we encounter there are not due to any especial colouring-matter. White is due merely to the reflection of light through colourless tissues containing air. Blacks owe their origin merely to the dense concentration of violet pigments. If we set aside chlorophyll green, which is rarely met with in flowers [but in fruits ?], we may recognise the three following groups of colours :—1, yellows ; 2, reds ; and 3, blues and violets.

As was previously demonstrated by Hildebrand, the yellows are mostly in combination with the plasmic substance, whilst the colours of the second and third group are generally found existing in solution in the cell-sap.

The yellow of flowers forms an insoluble compound with fatty matters, as was demonstrated by Krukenberg in the animal kingdom under the name of lipochrome. [This circumstance may go far to account for the general comparative permanence of the yellow colours both of plants and animals.] The yellow pigment obtained by Hansen in a pure crystalline state, by saponification with soda and extraction with petroleum ether, agrees in its behaviour with the lipochromes. The spectra of the pigments of different yellow flowers agree with each other so closely as to lead to the conclusion of their mutual identity. Between the F and G lines there occur two absorption-bands, which do not, however, always occupy exactly the same position. The solutions are not fluorescent.

Orange is formed by a denser deposit of the yellow pigment. Thus the colour of the rind of an orange is due to the same pigment as is found in the yellow flowers of *Ranunculus repens*.

The colour of yellow dahlias and of lemon-rind is not a lipochrome. It is soluble in water, and behaves differently both chemically and spectroscopically, displaying, for instance, no absorption-bands. It is very similar to the pigment of *Æthalium septicum* examined by Krukenberg.

The reds of flowers may be reduced to a single pigment, —the rose-dye of roses, carnations, peonies, &c. It is soluble in water, and is decolourised by alcohol, probably in consequence of dehydration. On the addition of an acid the colour is restored. The spectrum displays a broad absorption-band between D and F. The varying intensity of the colours of roses, carnations, and peonies depends probably on the presence of acids. The scarlets and brick-reds of poppies, scarlet lilies, the berries of the dog-rose, &c., are produced by the simultaneous presence of lipochrome.

The blue and violet pigments turn pale also in alcohol. The solution is reddened by the addition of an acid, as was noticed by Fremy and Marquardt. They assumed therefore that the red colours were merely blue pigments modified by acids. Hansen, on the other hand, holds that the blue and violet colours are derivatives of the red. In favour of this view is the fact that certain blue and violet flowers (Boragineæ) are at first red. [The flowers of *Erica cinerea* are on opening red, but turn more to a violet on fading. On the contrary, the corolla of many fuchsias passes from a bluish violet to a red.] Salts of iron turn the red of peony flowers to a violet. Perhaps their action is similar during the life of the plant. It is well known that gardeners can produce blue Hortensias by adding iron to the soil. Peony red is turned to a violet by the addition of sodium phosphate, and larger quantities of the same reagent render it blue. The spectrum of the blue and violet pigments has two absorption-bands between D and *b*. These pigments also may be combined with lipochrome yellow, thus producing the colour of the berries of *Ampelopsis*. Hansen does not refer to the red, blue, and violet colour granules which occur here and there in flowers and fruits. He assumes, therefore, only four fundamental pigments:—Soluble yellow, lipochrome yellow, flower-red, and chlorophyll green. He opposes the view that all colours are derived from chlorophyll green, since their spectra do not agree. The change of colours of green fruits and green leaves in autumn he accounts for by the destruction of the chlorophyll, and either the simultaneous formation of new pigments or the unmasking of lipochrome which existed previously, but which was concealed by the chlorophyll. Brown decomposition products cooperate in the production of the autumnal colours.

V. A CONTRIBUTION TO THE QUESTION OF THE IMMORTALITY OF THE PROTOZOA.

PROF. AUGUST WEISMANN has recently given, in the "Biolog. Central-Blatt" (vol. iv., pp. 650 and and 677), a summary of his views on the life of monocellular animals. He concludes that—

1. The controversy whether it is proper in cases of the fission of Protozoa to pronounce mother and daughter as one and the same individual, or as distinct beings, is a mere logomachy. It has a deeper meaning only when we recognise that in these monocellular beings there is no "individual" in the same sense as in the higher organisms. Indeed our abstractions—such as "generation," "mother," "daughter"—are not at once universally applicable, as they are artificial concepts, and not things existing in Nature.

2. The idea of a "senescence" of monocellular animals is not tenable. Physiologically speaking there is a profound difference between the monocellular and the polycellular animals, in the fact that the latter only wear themselves out by living, and proceed to a natural death. The monocellular animals are never so modified by the transformation of matter that life becomes impossible. The monocellulars have no physiological death; their bodies are immortal.

3. Conjugation in the monocellulars and the process of fecundation in the polycellulars are analogous processes, and cannot be regarded as processes of rejuvenescence in the sense of an avoidance of physiological death. This latter occupies a quite different place in ontogenesis, and has nothing in common with these processes.

4. The body of the monocellulars corresponds to the germ-cells of the polycellulars. The sexual propagation of the latter may, with certain limitations, be viewed as an alternation of generations. We have first a generation of monocellular beings,—the germ-cells,—and next a generation of metazoic individuals, which again reproduce, in a nonsexual manner, a generation of monocellulars. The state of the case is more accurately represented by the conception that we have here before us an infinite series of monocellulars, the germ-cells, each generation of which splits off a metazoic individual or produces it as a bud. At any rate

we trace along with the infinite chain of monocellular generations a corresponding number of individuals of a higher order,—polyzoic individuals,—which, unlike the monocellulars, do not emanate directly from each other, but only through the mediation of mono-cellular beings. These individuals of a higher order, alone, have a physiological end—a natural death. The monocellular generations—germ-cells—are potentially as immortal as the Protozoa or other independent, monocellular organisms, since they are not absorbed in their buds, the Metazoa, but split off from them, living on in the interior of such Metazoa, whence they derive protection and nourishment.

VI. ACCLIMATISATION.

By J. W. Slater.

THIS ungainly word has in practice a very different meaning from that which its etymology would show. As commonly used it means the introduction of any alien plant or animal into a country through human agency. Whether such immigrants had to be gradually adapted to their new home by a series of physiological modifications, or whether they found it equally congenial with their mother-country,—or possibly more so,—is not the question.

Another glance at the word may be useful. It seems to imply, if not directly to connote, that the main reason why any animal or plant flourishes in one country, but perishes in another, is some difference in the *climate*, in the geographical sense of the term. In other words, it conveys the impression that the animal and vegetable population of a country depends solely upon its mean or its extreme temperature at different seasons of the year, upon atmospheric pressure, or upon degree of moisture. Now without ignoring the influence of these physical conditions of life we must remember that they are not the sole, nor even the leading, agencies in determining the flora or fauna of a region. There are good physical reasons why humming-birds are not found in Iceland, Greenland, or Siberia. There are no such reasons manifest why they might not flourish in Madagascar, in Borneo, or New Guinea, as well as in Guatemala or Brazil.

I said above "the introduction of a living species through human agency." I might have added "intentional or accidental." It must not be supposed that man has knowingly, and of set purpose, selected as his companions those living beings which have accompanied him in his wanderings. Far from it: as proof to the contrary we may mention merely the cockroach and the grey rat—Norwegian of earlier writers, Hanoverian of Charles Waterton, but more truly and more significantly Russian! Man would no more wilfully acclimatise such creatures than he would the smallpox or the cholera.

It is often thought that acclimatisation is fostered and recommended by scientific men. Such is by no means the case. The genuine zoologist or botanist looks upon the introduction of alien species into any country with as little pleasure as the classical scholar regards the interpolation of spurious passages in some ancient author. Even here in England doubts have already arisen whether certain plants are truly native or whether they have been artificially introduced. That the consequences of the artificial immigration of plants and animals may teach us certain grave biological lessons is a partial compensation for the obscurity which it is occasioning in organic geography I admit. But none of us would have made the experiment. No savant, no scientist—why have we no genuine English term for such men?—would have carried goats to St. Helena, rabbits to Australia, or "cabbage whites" to North America, merely to see what would happen.

We must remember that "acclimatisation" is a very serious thing—far too serious to be left to the indiscretion of individuals. We are justly warned that even the extirpation of existing forms of animal and plant life is a task which ought not to be undertaken with a light heart and without well counting the cost. But the risk in introducing some alien species is tenfold graver; the step once taken may prove, as far as man's present resources are concerned, irrevocable, and the consequences cannot in the least be foreseen. Of this I shall presently give some examples.

Perhaps the first lesson to be learnt, scientifically speaking, from our present experience in acclimatisation is the fallacy of one of the dogmas of the Old Natural History. It was formerly held and taught that the plants and the animals of any given country were especially, and by particular arrangement, adapted to the soil, the climate, and all other circumstances of that locality. Hence it was supposed that, if transplanted to any other country, they would be less prosperous than at home, and that, conversely, species brought from elsewhere would maintain their ground with difficulty, if at all.

This doctrine, it may be remarked, involves almost of necessity the theory of a plurality of centres of mechanical creation, or otherwise a series of elective migrations and transformations which in their outcome approach very nearly to Evolution.

There are, indeed, many cases where the plants and animals of one country—the former more especially—seem limited to their original locality. Thus the durian and the mangosteen of the Malay Islands utterly fail in the West Indies, and the shaddocks of the Azores and the Antilles are "flavourless as turnips if compared with those of Bangkok or Labuan."

But there are no less signal instances to the contrary. The thistle brought from Scotland to Australia grows there with a luxuriance quite unknown in its native soil. Even the sweet-brier—which is nowhere exceedingly common or rampant in Britain—is becoming in New South Wales a serious nuisance which the farmer and the gardener are obliged actively to combat.

Nor are these exceptional cases even among plants. With animals there is still less difficulty. The rat multiplies in every corner of the globe where it has penetrated no less readily than in its original home on the Wolga. The rabbit, foolishly—or I might say criminally—turned loose in Australia has proved itself an almost unlimited curse. The sparrow, acclimatised in the United States, in Australia, and in New Zealand, contrary to the advice of judicious European naturalists, has not only established itself, but is seriously interfering with the original bird-population. Descending lower in the scale—if I may so say—of animal life, it is certain that the cockroach, or "black beetle" of unscientific insect-lore, is not indigenous in Britain. It is no less certain that its extirpation is about as unlikely as the conversion of the Anti-Vivisectionists to common sense and common honesty. Blood-sucking gnats, according to Baron Osten-Sacken, were only introduced into the Sandwich Islands about 1828 to 1830: they have since spread, and are becoming a serious nuisance. The same eminent authority states ("Trans. Entom. Soc. of London," 1884, p. 492) that the two-winged insects popularly "lumped" together as house-flies, such as *Musca domestica* and *Stomoxys calcitrans*, "have been imported into Chili, Australia, and New Zealand, where they were not indigenous," and where, it may be added, they are multiplying and growing formidable. The United States, even, seem to have been originally free from this plague. Hence it may be safely asserted that the aboriginal plants and animals of any country are by no means necessarily confined to that country, but that when intentionally or accidentally transported elsewhere they may flourish as well as—or even better than—at home.

This latter portion of the proposition is merely an extension of the observation of Dean Herbert, that we do not of necessity find plants growing in the soil or the station best suited for their wants, but often where they are most secure from the rivalry of encroaching species.

I am next compelled to bring forward a consideration which will, I fear, lay me open to the charge of pessimism. There is scarcely any instance where a beautiful, a useful, or even a harmless plant or animal has been accidentally introduced, and where, if imported purposely, it has been able to dispense afterwards with man's care and protection. On the contrary, the species most commonly and easily naturalised are weeds and vermin. This is a striking and a most distressing fact, shadowed forth in the primal curse:—"Thorns also and thistles shall it bring forth unto thee."

I may be asked for a definition of "weeds" and of "vermin." These names are applied to organisms which satisfy neither our æsthetic nor our economic wants, and which are often actively injurious to our persons or to our property. Decided beauty may make us overlook uselessness, and manifest utility makes us condone ugliness. But the injurious plant and the harmful animal, even if beautiful,—a very rare case,—are invariably written in the *Index expurgatorius*. There is, of course, scope for some little difference of opinion as to what species are ugly and which are hurtful, but these dissidences do not affect the general principle.

We have to look yet a little further. To the very essence of a weed or a vermin belong great reproductive power, tenacity of life, and adaptability to varying conditions. But for these last attributes ugliness and uselessness would escape notice, and positive harmfulness would be practically neutralised. Now the misfortune is that beautiful or useful organisms rarely possess these features in any marked extent, whilst ugly and useless or pernicious species manifest them very strongly. Surely a grim satire on the "survival of the fittest"! Whatsoever we would wish to destroy survives, sets us at defiance, and spreads round the globe like a pestilence. Whatsoever we wish to preserve taxes our constant efforts, is often in danger of extirpation, and rarely—very rarely indeed—succeeds in spreading spontaneously into new regions. It is easy to enumerate beautiful plants, such as the lily of the valley and certain of the choicer ferns, which are assuredly disappearing from the British flora.

In like manner the roller, the oriole, and the bee-eater have vanished from our fauna, and the kingfisher is surely following them. We need, therefore, scarcely ask why such species do not attend the footsteps of our colonising pioneers?

It may be said that lovely flowers, birds, and insects are extirpated on account of their beauty. A careful examination will show that this is not the fundamental fact. Lilies of the valley in our woods and field-edges are carried off for sale wherever seen. But what a far wider devastation falls to the lot (say) of the groundsel, the thistle, the dock, &c. Every gardener, from the extensive nurseryman to the humblest amateur, massacres these plants by thousands. So does every farmer. They have also other enemies. Their seeds are the food of birds; their leaves are attacked by caterpillars, and their flowers and buds by Aphides. But are they decreasing? We may congratulate ourselves if we can keep them from gaining further ground.

It is surely a difficult problem to say why and how tenacity and the power of multiplication are thus, apparently at least, preferentially linked with ugliness and harmfulness. But, admitting the bare fact, we need not wonder why the plants and animals which we admire should so rarely become accidentally acclimatised.

The main peril of naturalising any species lies in the circumstance that we can rarely judge how its habits and its powers may be modified by novel surroundings. We know now that the diet and the rate of increase of an animal are not points immutably fixed, but are open to change. If a destructive insect is conveyed to a climate where the summer is longer and more decided, it may produce an additional brood of descendants every season. A still more frequent case is that in its original home it may have been kept in check by some parasite or other destroyer. But when transferred to another hemisphere these enemies may not have accompanied it. Hence its increase is, for a time at least, unbounded. Not a few of the most destructive insects in the Atlantic States of the American Union are old-familiar denizens of Europe, and have there done comparatively little damage. But introduced to "fresh fields and pastures new" they multiplied in a manner previously unimagined.

Herewith is connected a curious fact: the plants, the animals, and the diseases of the Eurasian continent have a much greater tendency to become cosmopolitan than have those of America and Australia. A goodly number of European plants—practically all of them vile weeds—have reached California, Australia, and New Zealand, have there become wild, and are to a lamentable extent displacing the native vegetation. But the instances of an American plant having become naturalised in any part of Europe are exceedingly rare. And so far we think that no Australian plant has established itself in Europe, save under cultivation. In explanation of this fact, which I must take the liberty of calling an unpleasant one, it is said that the flora of the great Eastern continent is composed of the survivors of a struggle for existence more intense, prolonged, and diversified than can have raged in any other part of our planet. Forms which have emerged victorious from such a contest have naturally great odds in their favour when brought in contact with the flora of Australia, of New Zealand, or even of America. Very similar is the case with the fauna.

This brings us to another side of acclimatisation: when we introduce into any country an alien plant or an alien animal we have not simply the old flora or the old fauna *plus* the new comer. We have brought into play a disturbing element, a ferment,—if I may borrow a chemical expression,—and we have thus set up a process of decomposition, so to speak, in the animal and vegetable population of the country. Each new plant that can maintain itself outside the limits of our gardens or fields, each new animal that can exist in a feral or semi-feral condition, intensifies the struggle for existence, and leads to the extirpation of more or fewer native species.

There are those who will thoughtlessly say "Let them fight it out, and let the best win." But the species which succeed in the struggle for existence are not the most beautiful or the most useful,—often quite the contrary. It seems highly probable that though "natural selection" up to a certain point may have served to increase the number of organic species, yet if that point is exceeded its action is rather destructive. In like manner, if competition between man and man were totally removed, the race would degenerate. But if it reaches such a degree of intensity as it has done in our times, it compels men more and more to fix their sole attention upon what is immediately useful, overlooking all labour which promises greater rewards in the future. In this manner creative minds find themselves at a discount.

How far-reaching may be the effects of the introduction of a single new animal species is best shown at St. Helena and at the Cape of Good Hope. In both these regions goats were acclimatised by European settlers. One of the most prominent attributes of these animals is to browse down seedling trees and shrubs. In consequence, as goats multiplied, and as the old trees in the woods died off, there were no young trees to take their places. The woods disappeared little by little; the shrubs and low-growing vegetation which had flourished in their shade perished likewise. The birds and the insects which found shelter and nutriment in the trees could not survive. In this manner the native flora and fauna of St. Helena have been so completely blotted out that their nature is a mere matter of conjecture.

Still this is not all; when a country is denuded of woods the rainfall, instead of being moderate and regular, is reduced to violent deluges, interspersed with intervals of withering drought. The soil, being no longer held together by the roots of trees and herbage, is torn away by the violent rains and washed down into the valleys and river-beds, whilst the uplands remain barren wastes of shingle and boulders henceforth incapable of cultivation. To this state millions of acres of the finest land in the world have been reduced by acclimatisation!

I think that all colonies should forbid, under the severest penalties, the introduction of any weed, any mammal not living in a state of domestication, and any such bird as the sparrow. The men who brought the thistle and the rabbit into Australia have done more harm to the human race than if they had committed a hundred murders.

VII. A NEW COSMOGONY.

THE celebrated hypothesis of La Place, after having been first generally execrated and then all but universally accepted, is now encountering opposition of a sober and substantial kind. It fails to account for facts as they now are known to astronomers. Hence a new hypothesis is required, and accordingly such a one has been produced by M. Faye, and has been laid before the world in a recent issue of "L'Astronomie."

A brief recapitulation of the facts of the case will be necessary for an understanding of the basis of the new hypothesis.

Neither the aspect of the heavens nor the appearance of the planets gives us the slightest conception of the Solar System. In order to understand correctly we must in thought leave our world, and withdraw to such a distance that we can with a single glance take in the little system the centre of which is occupied by so ordinary a star as our Sun.

Round the Sun there move, at very unequal distances, eight primary planets. Of these planets six have satellites, —*i.e.*, they are the centres of small systems which represent the Solar System on a reduced scale. Thus the Earth has one satellite (the Moon), Mars has 2, Jupiter 4, Saturn 8, Uranus 4, and Neptune (the most remote planet hitherto known) 1. A striking phenomenon in this our own system is, that the Sun revolves on its axis from right to left; that all the planets, without exception, move in the same direction and almost in the same plane—that, namely, of the of the rotation of the Sun; and that they describe almost circular orbits.

Might it not almost be said that all these bodies are animated by one great vortex movement, and that the secondary systems of the Earth, of Mars, Jupiter, &c., are smaller vortices moving in the main vortex? Such was, indeed, the view of Descartes. Although the Solar System generates at present no vortex, it has been originally formed by a vortical movement in the nebula from which it has been formed.

The heavens display here and there a great number of gigantic masses of rarefied matter, resembling the formless mists of chaos which have undergone only the degree of condensation necessary for the production of a faint light. We generally require a powerful telescope to recognise these nebulæ, but then we may perceive them in the heavens by thousands, and of several different kinds.

The nebula in Orion has no sharply defined form ; a more luminous region can be distinguished in the mass in which the condensation of the chaotic material is most advanced. In all other parts the light is faint. We distinguish merely long streams of luminous matter the meaning of which it is impossible to divine.

The nebula in Andromeda is one of the most remarkable objects in the heavens. It has an almost geometrical form, and in its centre it displays a very distinct condensation.

The nebula in Leo shows nebular rings which appear to be in process of formation.

Lastly, the peculiar double nebulæ of Virgo, Aquarius, &c., are evidently not far from their final transformation into stars.

It would not be difficult to increase the number of the intermediate stages, and, *e.g.*, to point out certain nebular stars which are in the penultimate stage of this series of transformations, which begins with a faintly luminous, shapeless mist, and ends with a sun, or with several suns connected in manifold ways. There is no occasion to say that we have not been present at these transformations. Here we resemble the botanist who in a forest can study the trees in their various stages of evolution. Thus the creation of the universe is, in a manner, proceeding before our very eyes. In the beginning, nebular spots which have separated themselves from the universal chaos; ultimately, glowing stars or other orbs so small that we cannot see them, since their formation evolved so little heat that their light is already extinguished.

Let us now suppose that from some cause—of which hereafter—the spirals of a whirling nebular spot are transformed into concentric rings governed by a common rotatory movement. Objects of such a form really occur in the heavens,—*e.g.*, the ring-shaped nebula of Lyra.

If such heavenly bodies are rare it is because they have little stability. It is merely a state of transition. On account of the differences in their linear velocity which here predominate, and on account of the mutual attraction of their parts, this last cause produces vortices, because they are compelled to follow the same way with different velocities, to coalesce, and to lose themselves in a single nebular mass in which by degrees all the matter of the rings will be absorbed. This nebular mass, which possesses a rotation in the same direction as the ring, will in turn produce a planet, surrounded by satellites revolving in the same direction and in the same plane.

We have thus a series of nebular rings, some of which display the vertical motion which eventuates in the formation of a planetary mass. At the same time the enormous quantity of material in the midst of the original nebular spot not used up in the rings unites by degrees in the centre, very slowly at first and afterwards very rapidly, thus producing a central orb,—a sun which revolves on its axis in the same direction and in the same plane as the planets.

We see thus how a slow, more or less indistinct, vertical motion can be carried so far that it causes the formation of these circular rings, all concentric and all in the same plane.

For this theory it is essential and sufficient that the solar nebular spot in the first moment was spherical and homogeneous. In such a mass of matter the internal gravitation derived from the attraction of all molecules varies in direct proportion to the distance from the centre. The particles of the small bodies which move in such a medium of inconceivable rarity necessarily describe ellipses or circles around the centre in equal times which is also their distance from that centre. The existence of rings revolving as a whole with the same movement is quite reconcilable with this condition of gravitation. If a rotatory movement has preexisted some of the spirals which do not differ much from circles will be gradually transformed into the above-described rings, on account of the smallness of the resistance from the centre.

Let us take a further stage. In consequence of the attractive force these rings generally tend to break up to form a globular nebulous mass, which finally includes all the material as the ring. These secondary nebular spots must necessarily have the same direction of rotation as the rings. Phenomena exactly similar to those of the primary nebula will appear,—that is, they will be resolved into concentric rings and then into a central orb. The rings on their part will condense into other very small orbs (satellites) which revolve around each planet, always in the same direction, whilst the planet turns on its axis exactly in the direction and in the plane of these secondary rings.

In this way, therefore, all has proceeded. By a fortunate accident some of the rings of the small secondary system of Saturn have escaped destruction, and have not been transformed into satellites. M. Faye ascribes their existence to the enormous rarity of these rings and to their rapid rotation.

We should thus have completed the explanation of the Solar System if this system had not a striking peculiarity which is apparently in full contradiction to what has been said. Of the eight planets revolving around the Sun six have satellites, and form thus secondary worlds,—accurate pictures of the Sun-world to which they all belong. According to what has been said all the rotations and revolutions must take place in the same direction, and, what is more, in the "direct" direction. But in the secondary worlds of the two most remote planets, Uranus and Neptune, the rotations and revolutions of the satellites are in the reverse direction,—they are "retrograde."

Are we to believe that the theory just laid down is false? It is not false, but incomplete. And thus we come to one of the most interesting points in the history of Science. Newton and La Place held that all rotations and revolutions must ensue in the same direction. La Place went further, and applied to this question the theory of probabilities. Occupying himself with the planets and satellites as then known, he calculated that if a new planet or satellite should be discovered the probability was 10,000 to 1 that the revolution of the satellite or the rotation of the planet would be in the same direction as all the others—a probability far greater than that of the historical events which we accept with the greatest confidence. The investigation of the satellites of Uranus and the discovery of Neptune have with one stroke annihilated this probability, and therewith the far-famed cosmogony of La Place. This hypothesis deduced all the planets from the Sun. It consequently assigned to the planets and the satellites the same relations and the same direction of rotation and revolution throughout the entire Solar System. In reality they are direct in the inner part and retrograde in the outer.

We will now complete our theory. In the primeval, spherical, and homogeneous nebular spot, where the presence of rings revolving round the centre cannot modify the law of internal gravitation, we saw that this gravitation is modified in direct relation to the distance from the centre. Subsequently the Sun was formed by the coalescence of all the matter which had not been used up in forming these rings; thus an empty space was formed around the Sun. Thereby the action of gravitation in the interior of the system thus modified was totally altered. By the action of the enormous solar mass—exceeding that of the rings more than 700-fold—the internal gravitation was changed not in the direct ratio of the distance, but inversely as the square of the distance from the centre; and this is the state still prevailing.

In this latter case the manner of the revolution of a ring of dispersed matter becomes completely different. We must not omit to mention that this change does not affect the existence of the ring. Of this Saturn is the proof.

But whilst according to the formerly existing law of gravitation the linear velocity of revolution in these rings increased with the distance, the velocity according to the second law decreased in proportion to the square root of this distance.

In the former case, when the ring has become transformed into a secondary system,—*i.e.*, into a nebular spot with external rings, and ultimately into a planet with its satellites, —the rotation of the planet and the revolution of the satellites will ensue in the same direction as that of the original ring,—*i.e.*, it will be direct. In the second case, the secondary system thus formed will be retrograde.

What must we therefore conclude? It is clear that the planets from Mercury to Saturn, which lie in the central region, have been formed according to the first law, when the Sun did not yet exist, or at least had not assumed a preponderating mass, and that the planets which lie in the outer and far more extended region were formed after the origin of the Sun.

If it should be discovered that Venus has a satellite, its motion must be direct. If a planet is discovered beyond Neptune, its rotation and that of its satellites will be retrograde. We have thus arrived at a proposition of extreme importance: *the Earth is much older than the Sun*. Were it otherwise, as according to La Place its origin was subsequent to that of the Sun, the aspect of the heavens would be entirely different. The stars would rise in the west and set in the east, and the Moon would have a retrograde movement like the satellites of Uranus and Neptune. We will add that they were formerly further remote from the centre than at present. For when the matter which lay outside the Earth's orbit passed over it, in order to unite in the more central regions for the formation of the Sun, then, as the attraction of the latter gradually obtained the supremacy, the period of the planets within the orbit of Uranus would be accelerated. These planets approached nearer to the Sun at the same time as their satellites withdrew further from their respective primaries.

Finally the present state of things became established, and its characteristic stability, as the mass of the Sun, having become enormous, was able to attract nothing more of the original nebular mass, and had rendered the space around it a void.

The universe has arisen out of chaos,—that means from an exceedingly rarefied, formless mass of matter, which filled a wide space and moved in various directions, in consequence of which the chaotic material became separated into distinct masses. By the progressive condensation of these masses of chaotic material towards certain centres of attraction have been formed the innumerable stars. Their incandescence comes from the heat developed during the process of their formation. Their stock of heat is limited, and ultimately they will go out.

Among all the infinitely distinct systems which have arisen by the consideration of this primeval chaos our Solar System may be regarded as a quite special case. The original nebula whence it was formed was spherical and homogeneous. As it became separated from other parts it took on traces of a slow vertical movement. These movements soon regulated themselves in virtue of that peculiar law of internal gravitation due to its form and homogeneity. Nebular rings were formed in the same plane long before the appearance of a central condensation. They produced the nebular masses, which also moved around their common centre in the same direction and in circular orbits.

The secondary systems formed in the same manner within this nebula may be sharply divided into two classes,—those which preceded the formation of the Sun, and which revolve on their axes in a "direct" manner, and the most remote secondary systems which were formed after the Sun, and which revolve in the retrograde direction. These striking phenomena presented by our Solar System are doubtless a rare exception in the universe, though they are merely the natural consequences of the original conditions and of the laws of mechanics.

With full right does M. Faye point to the importance of the proposition that the Earth is much older than the Sun. We cannot help, in passing, referring to the agreement of this view with the Mosaic cosmogony and with other ancient traditions.

But to the biologist, and we think we may say to the geologist also, the new hypothesis and its consequences must be much more satisfactory than that of Laplace.

A number of phenomena, both of organic geography and of palæontology, seem to indicate that life was first manifested on our globe in the Arctic regions, and extended gradually southwards, or, as certain neologists would perhaps say, *austrad*. But to this view there was one very serious objection. As far as we can judge, the fauna and the flora of genial climates could not exist in the Polar regions, whatever might have been the temperature, on account of the months'-long nights. But if we conceive of the Sun as a vast rarefied mass extending as far as the present orbit of Venus, and even beyond it, though shining with a less intense light than it now does, it is obvious that the long Polar nights of the present order of things could have had no existence.

There is another still more important. All our readers will be aware of the indiscreet raid which certain physicists have made upon geology and biology, asserting that if these sciences could not do with a shorter time than five hundred million years to account for the past changes in the Earth and its organic inmates, "so much the worse for geology and biology."

For our own part we never felt greatly alarmed at these calculations. It has been said that the Sun cannot have existed longer than a certain term of years, and that the Earth must necesssarily be younger. If M. Faye's hypothesis takes the place of that of La Place,—and it certainly accounts better for recognised phenomena,—the bases upon which the above-mentioned calculations were founded must entirely disappear.

Perhaps when astronomers and physicists have settled such comparatively simple questions as the temperature of the Sun, and even its distance, it may be time for them to lay down the law for biologists.

VIII. THE RELATIONS BETWEEN THE STATION OF PLANTS AND THE STRUCTURE OF THEIR ORGANS.

THIS subject has been recently studied by Professor Volkens, who has published a summary of his results in the "Annals of the Royal Botanical Gardens at Berlin" and in the "Naturforscher." He has especially investigated the action exerted by dry stations and climates upon the structure of the vegetative organs. Three methods for the examination of these relations are possible, and they have all been employed by Volkens. Either we may compare specimens of one and the same species, but from different stations, or we compare all the species of an order (or the orders of a family), or, lastly, all the typical plants of certain dry regions are submitted to a comparative examination.

In opposition to Sorauer's hypothesis, that evaporation is not a physiological but a mechanical process—an interpretation which offers no basis for the explanation of the protective agencies for checking transpiration — Volkens maintains that we have here to do with a purely physical process depending essentially on two factors,—the vapour-tension of the ambient air, and the nature of the evaporating membrane or liquid. As watery vapour is given off, both from the entire surface of the epidermis and through the interstices from the membranes lining the intercellular spaces, the evaporation will be the greater the more the surface and the intercellular system are developed.

The evaporation is greater from the epidermis and from the internal membranes, because the vapour-tension is generally smaller outside of the plant than within it. Under certain circumstances the epidermis requires an especial protection, in order to lessen the evaporation. This is effected both by thickening and cuticlisation of the membranes, and by a sliminess of the cellular juices.

The adaptation to station appears very distinct in *Polygonum amphibium*, two varieties of which, *terrestre* and *natans*, are often formed from each other. Though the stem in the aquatic form is considerably thicker than in the land form, the stem-tissue of the latter is twice as thick as that of the former, in consequence of the smaller diameter of the central air-channel. The terrestrial form has, besides, stronger collenchymatised rind-cells, not separated, as in the aquatic form, by intercellular spaces. The sheath enclosing the vascular bundles is more strongly developed, and the cells are often thickened until the lumen disappears. The vascular bundles are more numerous, and contain three times as many vessels as those of the aquatic form.

These differences are explained by the circumstance that the shoots of the land plant, exposed to the action of the winds, require a firm mechanical system, while the water-sprouts must be light so as to accommodate themselves to every movement of the water. The greater part of their volume is taken up by air-spaces, and solid elements are almost entirely wanting. The aërial shoots, producing more numerous leaves and existing in a drier atmosphere, evaporate to a greater extent than do the aquatic shoots, and hence in the former we find the system for the conduction of water more strongly developed than in the latter. Evaporation in the land plant is further diminished by the circumstance that the bark is only slightly developed, and that the air-spaces are insignificant.

We see, further, that the natatorial leaves, in order to avoid temporary submergence, by adapting themselves to the movements of the water, are provided with a long, but thin and permanently flexible, stem. The stem of the aërial leaves is six times shorter, and of nearly double the thickness. They are further mechanically strengthened by a tissue which projects like a keel from the midrib of the leaf. As the aquatic leaves are not in the shade, assimilation is in them more powerful, and hence the chlorophylliferous parenchyma is in them more strongly developed than in the aërial leaves. The latter are protected against too intense evaporation by numerous long hairs, pressed closely upon the surface of the leaf. The number of stomata is approximately equal in both forms, though in the aërial leaf they are chiefly on the lower, and in the aquatic leaf on the upper.

The large epidermic cells which occur singly on the upper side of the aërial leaf must be regarded as an especial adaptation to the dryness of the station. Their inner membrane is in a very slimy condition. These cells readily absorb water, and must be regarded as reservoirs which in time of need give off a part of their water and prevent the epidermis and the parenchymal cells from withering.

Further comparisons are next made between different species of one and the same genus. It appears that *Asperula odorata*, which inhabits moist and shady woods, possesses no means of protection against evaporation. On the other hand, species of the same group (*Asperula arvensis*, *tinctoria*, *cynanchica*, *galioides*) which all affect more or less sunny stations, are provided with more or less developed means of protection: thus the leaves are in some cases narrower, or their margins are spirally curled up, or there are special arrangements in the structure of the mesophyll and the rind. Without doubt the stomata of all plants of most stations are more frequently open than those of plants which have to contend with want of water.

The third method of investigation has been applied by Volkens to the flora of deserts, and especially of the Sahara. One of the groups there most generally occurring are the Leguminosæ, especially the genera *Genista*, *Spartium*, and *Retama*. These plants are especially enabled to bear the dryness of the climate by their leaflessness.

Our European species of *Genista* and *Spartium* proclaim, by their possession of leaves, that they are placed in more favourable circumstances as regards water. *Spartium scoparium* accommodates itself to the increased heat of the smallness of the leaves on its summer shoots, which are no longer triple, but single. Volkens is of opinion that all the dead and thick-walled elements within the vegetable body form in their totality a reservoir of water.

ANALYSES OF BOOKS.

The Story of a Great Delusion in a Series of Matter-of-fact Chapters. By W. WHITE. London: E. W. Allen.

WE have here a closely-printed volume of close upon 600 pages—not including a copious index—in opposition to vaccination. As might be expected the author makes some good points, not a few bad ones, and introduces much matter of doubtful relevance. He is fairly successful in showing that the statements popularly circulated concerning the former ravages of smallpox are overdrawn. But, like many of the anti-vaccinators, he forgets that the public horror of smallpox is not based upon the death-rate only. No statistics show the number of persons blinded by that disease—a result worse than death both for the individual and the community. Nor is disfigurement a mere sentimental evil. Let a pock-marked and a non-pock-marked person apply for any situation or appointment, the odds are heavily against the former. Hence the contention that the years of greatest smallpox mortality are the years of least total mortality, if true, is of exceedingly little moment.

Mr. White has the best of the argument when he shows that the introduction of vaccination coincided with a temporary decline of smallpox in the early part of the present century, and that it hence obtained credit for a result which had set in before Jenner's discovery. In fact, if we consider how small a proportion of the population was vaccinated up to the year 1830, we cannot ascribe the improvement to this operation without crediting it with a vicarious influence of great power. The author further raises the question, very pertinently, Which is the true vaccine matter? Is it the original idiopathic cow-pox or horse-grease, cow-pox or unmodified horse-grease, or smallpox refined by being passed through the cow? All these have been in use more or less at different places and times, and have been transmitted from one human patient to another. Hence the question is not unnaturally put by the sceptical, Which of all these is the real safeguard, or are they all efficacious?

But Mr. White's pleas are not by any means all equally happy. Thus he quotes approvingly from Mr. J. Gibbs the following passage:—"Cannot they who believe in vaccination protect themselves? Nobody seeks to hinder them. . . . In their anxiety to coerce others compulsory vaccinationists demonstrate their own want of faith in the prescription which they assert affords complete security from smallpox."

To these brave words we may reply that the upholders of compulsory vaccination, when an epidemic of smallpox breaks out, are liable to be taxed *ad libitum*, by the Asylum's Board, to isolate the sick and to prevent the further spread of the infection. Further, we may take the somewhat analogous case of conflagration, which the author himself elsewhere brings forward. There are certain methods by which wood, paper, or textile goods can be rendered uninflammable. If by accident there falls upon such protected material a lighted match, or a spark of fire, they do not become ignited. But if these prepared matters are thrown into a furnace, or heaped up with unprotected wood, &c., and a light is applied to the latter, the protection proves insufficient. Just so the vaccinated person may object to living in contact with an unvaccinated multitude who form a pabulum for the epidemic.

Mr. White seems to us in error when he argues that vaccination is worthless because the exaggerated anticipations of its early promoters have been refuted by facts. No one now contends, as was done by the friends of Jenner, that vaccination renders the subject for ever insusceptible of smallpox. Unless that view had been abandoned, whence the necessity for re-vaccination? But it is obvious that a degree of protection which falls far short of life-long immunity may yet be of very considerable value.

In answer to the assertion that vaccination is useless, we may ask when and where it has ever had a fair trial? or, in other words, when and where has an entirely vaccinated community existed? If it can be shown that smallpox is capable of making its way into such a community, we will at once acknowledge that the "Jennerian rite" is ineffectual. In the meantime we submit that the best means of bringing the question to this ultimate or crucial test would be the cessation, or at least the suspension, of the agitation.

As regards the communication of other diseases by vaccination, whilst we admit that it has actually taken place, we must urge the utter want of proof that the great increase, *e.g.*, of infantile syphilis complained of is exclusively, or even mainly, to be traced to this cause. Nor should it be forgotten that the Anti-Vaccinationists, if not entirely identified with the defenders of syphilis, are at least linked with them in very close alliance.

The imputation that vaccination is merely upheld by the faculty from interested motives is repeatedly conveyed throughout this work: now without asserting that medical men may not have their judgment warped by self-interest,—just as it may be the case with political agitators,—we must remember that the emolument derived from vaccination is so small that, if it has any effect at all in diminishing smallpox cases, medical practitioners in defending this precautionary measure are very literally "fighting against their own bread and butter."

Mr. White's views on the ætiology of smallpox are peculiar. He tells us that "smallpox, as naturally developed, is a crisis of impurity in the blood." This is what Comteans would pronounce a metaphysical explanation. Impurity of the blood, whatever that may mean, has surely existed at all times; but, in the absence of the specific variolous poison, it does not produce smallpox.

He ascribes the abatement of smallpox to "a progressive change in the diet of the people,—to the substitution of tea for malt liquors, and to the displacement of arid fare by potatoes." Again, he writes, "I am disposed to ascribe the abatement of smallpox, which set in toward the close of the last century, to the better blood of the people, ameliorated by the increased consumption of tea and potatoes." Yet though the consumption of tea has greatly increased, and that of potatoes has certainly not diminished, smallpox has again increased, and has repeatedly taken an epidemic form.

As to the irrelevant matter in the volume before us, it is abundant. The strictures on Jenner's private character are for the most part quite beside the question. Granting his shyness, his indolence, his arithmetical incapacity, his being "anxious, fitful, and helpless,"—all these prove nothing for or against the utility of vaccination. Even John Hunter, as having been Jenner's master, comes in for a share of abuse. From the language used, and from another passage, we should suspect Mr. White of a leaning to "Bestiarianism." Another mass of irrelevance is the chapter devoted to William Cobbett!

What we most object to in the present author, and indeed in the bulk of anti-vaccinationist authorities, is that they write not as men of Science, but as political partizans—as agitators. They do not calmly and judicially set to work to demonstrate the inefficiency and the dangers of vaccination; they seem to have set out from theories of "conscience," "liberty," &c., and then to have sought for scientific evidence as a support. We fear it may be deduced, from certain passages in this work, that the author and his friends would still feel free to carry on their agitation even if neither failures nor dangers ever resulted from vaccination.

We do not see that Mr. White fairly meets the objection that compulsory education jutifies compulsory vaccination. We, for instance, are compelled to pay School-Board Rates though we conscientiously believe that *any* form of education administered on the principle of "payment by results" is individually and racially destructive. Still this our belief, or rather knowledge, does not warrant our refusal to pay the school-rate until such time as the Committee of Council on Education comes to its senses. Why should not our conscience be equally respected with that of the Anti-Vaccinationist?

High-Pressure Education. Being an Exposition of the Evil Effects upon the Rising Generation of Hurry and Worry at School, with Suggestions. By F. CHURCHILL, M.B., F.R.C.S. London: Harrison and Sons.

THIS pamphlet scarcely justifies the hopes which its title seems to inspire. It contains, indeed, much of which we cordially approve, but at the same time it is not free from matter against which we must emphatically protest. Sometimes, too, the author is silent where outspeaking would have been the more excellent way.

He begins by reference to the observations of the medical staff of children's hospitals, concerning the "multiple forms of brain-mischief," the increase of headache, lassitude, pallor and sleeplessness, with brain irritability and chorea, which appear among their patients during recent years. From these evils he says, with perfect truth, that "the children in our Board Schools have suffered under the existing system of payment by results." This—and we wish Dr. Churchill had emphasized it more strongly—is the plague-spot on our system of National Education.

The author's personal experience warrants him in speaking with authority. He has had fifteen years' constant experience in children's diseases, with an average attendance upon over one hundred Board School children weekly, at the Victoria Hospital for Children.

As additional evils he refers to the want of systematic inspection of the sanitary arrangements of school-rooms. He speaks of the children sitting listlessly under the tyranny of "iron-bound codes."

He notes the frequency with which boys from 16 to 20 come under his care with nervous twitchings of the face, and he invariably finds that such boys "are undergoing a course of cramming."

Dr. Churchill next explains the *modus operandi* of over-pressure upon the brain and upon the entire system, and enforces a training for the body, *pari passu*, with that of the mind. He glances at the high percentage of insanity in England, and quotes the conclusion of Dr. Connolly, drawn from the statistics of insanity, that whilst "priests, painters, sculptors, poets, and musicians contribute largely to swell the ranks of the insane, those whose minds are engaged in more practical study, such as physicians, naturalists, chemists, &c., seldom become inmates of asylums." He fails, however, to draw the evident conclusion,—*i.e.*, the necessity of minimising the time and effort devoted to the study of words and abstractions, and turning the intellect to the consideration of things. An education based upon Science is therefore no less necessary for national health than it is for training up discoverers and inventors, the class of society whose numbers and efficiency in any country determines its greatness. Had Dr. Churchill duly weighed this part of his subject he would scarcely have written the last sentence of his pamphlet, to wit:—"Then may we hope for the day when mathematics and classics shall stand a chance of competing successfully with athletics and cyclics as the pleasurable pursuit of youths who are determined to make their very best way in the world." Mathematics are of course necessary as a preparatory discipline for the astronomer, the physicist, and perhaps the chemist; but of classics we have had far too much, and it is in consequence of that error that we make comparatively so poor a figure in scientific research. We must cultivate conception and origination in place of expression,—things instead of words,—unless we would as a nation fall hopelessly into the background.

Nineteenth Report of the Board of Visitors to the (Melbourne) Observatory, together with the Annual Report of the Government Astronomer. Melbourne: Ferres.

From this Report we learn that the weather forecasts are now extended to the northern districts of the colony. The Board strongly advise the introduction of incandescent lamps at the Observatory in place of gas, as the heated air is a source of inconvenience.

The death of Mr. Joseph Turner, one of the assistants, is put on record. The deceased had done much valuable work in connection with the revision of the Southern Nebulæ.

Long-continued earthquake disturbances have been felt in Tasmania during the past year, and they appear to be extending towards the southern part of Australia. It is therefore suggested that the Observatory should be fitted up with seismographical apparatus.

Elementary Text-Book of Zoology. Special Part: *Mollusca to Man.* By Dr. C. Claus, Professor of Zoology and Comparative Anatomy in the University of Vienna, and Director of the Zoological Station at Trieste. Translated and Edited by Adam Sedgwick, M.A., with the assistance of F. G. Heathcote, B.A. London: W. Swan Sonnenschein and Co.

In considering this work we can take notice merely of what is officially before us. Consequently the author's reasons for the classification he has adopted, and for the positions which he has assigned to certain groups, cannot here be brought into question. His position with reference to Organic Evolution must also be passed over as not distinctly apparent.

Passing at once to the end of the book, we find the author's views as to the place of mankind in the animal system mainly satisfactory. He states that the notion which formerly was so widely held, that man belongs to a special natural kingdom, above and outside the animal kingdom,—may now be completely put on one side as incompatible with the spirit and method of natural science." He pronounces that the peculiarities of man as compared with the apes "cannot be regarded as fundamental distinctions, but must rather be ascribed to gradual deviations, since there are still greater differences between the highest and lowest apes." He supports this view by showing that the morphological points formerly brought forward in proof of a profound difference of kind between man and ape have all been found wanting. And though he diagnoses man as possessed of "reason," he yet concludes, with Wundt, that "the mind of Man differs from that of beasts only in the degree of development which it has attained."

Still it may be contended that Prof. Claus does not assign to man any distinct position. He appends him to the order Primates, justly cancelling the two delusive Cuvierian orders "Quadrumana" and "Bimana." But he places him neither in a family nor a genus of the highest, or Catarrhine, sub-order.

The question whether Man is the highest mammalian form, as commonly supposed, or whether that position should be assigned to the cats, as contended by Profs. St. George Mivart and—we believe—by C. S. Minot, is not raised.

Concerning the unity of human forms no opinion is given—a prudent reservation. Nor have we any decision as to the number of the characteristics of the human races. Prof. Claus merely quotes on this subject the views of Blumenbach and of Cuvier, and briefly mentions the efforts of Retzius to found a more scientific classification.

A careful examination of this book will convince the reader that, as far as its compass allows, the morphology and the embryology of the principal groups are accurately and clearly expounded and well illustrated. There are no fewer than 702 woodcuts, well executed and taken from the first authorities, such as Kölliker, Gegenbaur, Balfour, Hyrtl, &c.

As regards the geographical distribution of animals it would, in our opinion, have been well if the author had adopted the system of Wallace and Sclater instead of giving such localities as the "New World," the "Old World," &c. Thus, under the Psittacidæ, we read, "Most of the parrots belong to America." Had Prof. Claus written "belong to the Neo-tropical Region" he would have obviated a possible misinterpretation.

Upon the whole, however, as far as can be judged from the volume before us, we must pronounce the work an admirable exposition of modern zoology.

Dismissing now the author and the subject-matter, we must turn for a moment to the translators and to the language employed. There has latterly been manifested, both in Britain and in America, a tendency to overload zoological works with unnecessary technical terms, of Greek and of Latin origin. This, we submit, is much to be regretted. It can no longer be assumed, as was perhaps the case a century ago, that every student of Natural Science is a classical scholar. On the contrary, the separation between these two spheres of study is daily widening. Why, then, should such books as the one before us not be written in a language intelligible to such as "know little Latin and less Greek"? Technical terms we must have, but a very large proportion of them might be English, and consequently "understanded of the people." Let us take an example: we read here that the Insessores are "usually divided, according to their vocal apparatus, into two orders—the singing birds, or Oscines, and the shrieking birds, or Clamatores." Why not simply say "singers" or "shriekers"? Again, with reference to the different state of development of birds when hatched, it is here written that some "at once follow the mother on land or into the water (præcoces); others leave the egg-membranes very early (altrices)." Now what extenuation is there for the coinage of the terms "præcoces" and "altrices," when "nest-quitters" and nest-sitters" would have expressed the facts much more precisely? The horrible terms "arctiodactylate" and "perissodactylate" might in like manner be advantageously superseded by "even-toed" and "odd-toed." The more we make the natural sciences matters of verbal memory, the more do we impair their educational value.

Practical Physics. By R. T. Glazebrook, M.A., F.R.S., and W. N. Shaw, M.A., Demonstrators at the Cavendish Laboratory, Cambridge. London: Longmans, Green, and Co.

Physical manuals and handbooks, each duly fitted with a tail-piece of the questions set at this or the other examination in years bye-gone, are threatening to become as great a nuisance as the corresponding class of books on chemistry have been. The work before us, we are happy to say, is of a quite different stamp. The authors do not propose to cram readers with a mere word-knowledge of instruments, processes, and results, but they teach the true student the art of learning by experiment.

The plan in use in the Cavendish Laboratory is one which deserves to be more widely known and followed in this country. It requires, of course, a complete set of apparatus; but any department of physical science taught without apparatus, and consequently without experiments, had better not have been taught at all.

The present work is a collection of the MS. details of the different experiments conducted in the elementary classes in practical physics. The authors, in their very interesting Preface, tell us that in their course of instruction the apparatus referred to in each section is placed together on a table. The students are arranged, for the most part, in pairs, and before each day's work the demonstrator in charge of the class assigns to each pair of students one experiment. A list suspended in the Laboratory shows the names of the students and the experiment assigned to each, so that each member of the class can know the section at which he is to work. He is then set before the necessary apparatus with the MS. book for his guidance, and if he meets with any difficulty it is explained by the demonstrator. The results are entered in books in a form provided, and after the class is over these books are collected and the entries examined. If the entries are correct a new section is assigned to the student; otherwise a note of the case is made in the class list, and the student's attention is called to it, or if necessary the experiment is repeated.

We may safely say that if this method of instruction is persevered in we shall have a crop of discoverers in physics springing up in place of men who have merely absorbed the results of their predecessors.

Our Insect Allies. By THEODORE WOOD. London: Society for Promoting Christian Knowledge.

THE author of this work takes extreme ground. Along with very instructive lessons, he ventures to assert "that not only is no insect absolutely injurious to our interests, but that there is none which, were we fully acquainted with its life-history, might not in some manner be utilised for our advantage." We are entirely with him when he points out the benefits which certain species confer upon us, and when he pleads for their protection. It is always painful to us when taking a morning walk to notice the number of such useful creatures as Carabs and Geotrupes which the British workman has crushed when on his way to his daily employment. But we must never forget that the great claim of many species—not merely insects, but animals in general—is that they rid us of others.

Mr. Wood says:—"If by a single word, for instance, we could sweep the Aphis or the cabbage-butterfly from the face of the earth, that word ought never to be spoken." Now the damage done by the Aphis and the cabbage-butterfly is so immense that if it is to be compensated, and even outweighed, by any services rendered, those services would have to be of corresponding magnitude, and could scarcely be overlooked. It is in vain to talk of their life-histories requiring to be better understood. The Aphis and the cabbage-butterfly have been most minutely studied,—the latter, for instance, in Herold's "Entwickelungs geschichte der Schmetterlinge,"—but no redeeming feature has come to light. They do not destroy any hostile species; they do not remove putrescent matter. In fact there seems to be no chink or cranny left for any benefit to us. Nor do we find any evil increase when and where they are relatively scarce, and decreasing, on the contrary, when and where they are numerous. It is very true that we occasionally discover some small redeeming feature in the character of such beings as the earwig, in illustration of the old proverb "It's an ill wind that blows nobody good." But quite as often we discover that our animal allies are untrustworthy, and that our enemies have worse attributes than we could formerly have conceived.

Thus Mr. Wood tells us that the good offices of the gnat—and we should presume of all its congeners—far outbalance its bad qualities. Now did these creatures spend their whole lives in the water, there would be some grounds for this assertion; but during their aërial life they not merely make man and various warm-blooded animals miserable alike in polar and in tropical regions, but they are the active propagators of disease; the liquid which they instil into our blood, when biting, is a septic poison.

Mr. Wood forgets that there are different classes of insect scavengers; some which, like the burying beetles and the dung beetles, busy themselves with carrion and excrement alone, and never settle upon our food or our persons. Such are, to the best of present human knowledge, purely beneficial, especially when they bury the offal and the odure upon which they prey in the earth. But, sad to say, these best scavengers are not increasing, but seem to be rather on the wane.

There are other insects which after feasting on diseased or putrescent matter pass directly to our faces. Now what should we think of a community where scavengers, nightmen, and knackers were permitted, without any intervening washing or disinfection, to act as provision merchants, dairymen, sick-nurses, or surgeons? Malignant tumour is often caused by the bite of flies which have been feasting on the remains of diseased cattle.

As an instance of the untrustworthiness of some of our insect allies, the author might have mentioned the cannibal propensities of at least one species of labybird (*Coccinella bipunctata*). We have been often sorry to see with what eagerness the larva of this species preys upon the inactive pupa, and this, too, in cases where there is an ample supply of ladybirds close at hand. Surely this propensity must greatly limit its efficiency as a destroyer of Aphides. The *Telephori*, "soldiers and sailors" of popular nomenclature, which the author does not mention among our insect allies, does not seem guilty of this blunder.

The cannibalism of the ladybirds is an instance of the slight sensibility to pain which the author notices as characteristic of insects. We have seen pupæ which even in the very act of being devoured appear supremely indifferent to the transaction.

We may sum up our opinion of this book by pronouncing it interesting and valuable as far as facts go, but of very questionable authority in matters of inference or of speculation.

Louis Pasteur: His Life and Labours. By his Son-in-Law. Translated from the French by Lady Claud Hamilton. London: Longmans, Green, and Co.

So far as scientific literature is concerned the volume before us may emphatically be called "the book of the season." Biologists and chemists have of course followed the labours of the great French *savant* with an interest not the less sympathetic and appreciative because often crititical. But the outside world, educated and cultured, though not specialistic, stands sadly in need of better instruction concerning Louis Pasteur and his life-task. Did we not see him, in a work noticed in this very number of the "Journal of Science," denounced as a "ghoul?" We are glad, therefore, to find him and his achievements here pourtrayed in non-technical language.

The present edition of M. Radot's biography of his illustrious father-in-law is rendered more valuable by an introduction from the pen of Professor Tyndall.

The leading ideas which Pasteur has followed out in his manifold researches are the old doctrine *omnia ex ovo* and the part played by minute organisms in the changes both of animate and inanimate matter. His studies have therefore led him into the border-land of the two sciences, biology and chemistry,—a region which he has proved to be indeed fruitful. It need scarcely be said that he has been the most persevering and successful opponent of so-called "equivocal generation,"—the origin of life without antecedent life. In not a few cases where previous experimentalists believed that they had succeeded in producing minute organisms from lifeless matter, Pasteur has been able to find some capital flaw in the *modus operandi*. Experiments in the same direction have been performed with every precaution by Prof. Tyndall, and with negative results. Microscopists such as Dr. Dallinger and Dr. Drysdale have further shown that the germs of plants and animals may survive temperatures far exceeding that of boiling water, and may exist where observers less acute and patient found merely a lifeless void. But we may even say that the crucial experiment is being daily performed by commerce on a vast scale. If microbia were capable of originating spontaneously from organic matter we should see the tins of Australian meat and other preserved esculents arrive swarming with life and in a flourishing state of decomposition. But this is not the case except some flaw in the soldering has admitted the air, and with the air the germs or spores which are very rarely absent.

Studies like these naturally led Pasteur to scrutinise the boundary line—if so it may be called—between the organic and the inorganic worlds. For whilst he has been so active in showing that man has not yet succeeded in producing artificially either living beings or the substances essential to organic life, he has nowhere, to our knowledge, proclaimed such a result impossible. On the contrary, he has even thrown out suggestions how this task may be attempted. His contention is that organic products are "atomically dissymmetric,"—this dissymmetry being shown in their power of turning the plane of polarised light. Mineral matter, on the other hand, and the secondary products of organisms—such as those which have been artificially produced in our laboratories, urea, oxalic acid, &c.—have no action on polarised light. He maintains that "the forces which are present and active at the moment when the grain sprouts, when the egg develops, and when under the influence of the sun the green matter of leaves decomposes the carbonic acid of the air, are of the dissymmetric order." He is inclined to think that "life as manifested to us must be a function of the dissymmetry of the universe or of the consequences that follow in its train."

He suggests the attempt of introducing a manifestation of dissymmetry among the forms of crystals by means of magnets. "At Lille he contrived a piece of clockwork intended to keep a plant in continual rotatory motion first in one direction and then in another." He further proposes, "with the view of influencing the vegetation of certain plants, to invert by means of a heliostat and a reflecting mirror the motion of the solar rays which should strike them from the birth of their earliest shoots."

He is further quoted as saying:—"When the attempt is made to introduce into living species primordial substances, inverse to those now existing, the great difficulty will be to master the tendency proper to the species, a tendency which is potential in the germ of each of them. In this germ, it is to be feared, the dissymmetry of the dissymmetric primordial substances which it embraces will always manifest itself. Ah! if spontaneous generation were possible; if we could form from mineral matter a living cell, how much more accessible would the problem become! However this may be, we must seek, by all possible means, to produce molecular dissymmetry by the application of forces which have a dissymmetric action; we must invoke the action of solenoid or helix."

It is, however, only fair to notice here the criticism of Professor Tyndall. He reminds us, in his introductory chapter, that the molecular dissymmetry upon which Pasteur lays such great emphasis is simply a hypothesis to account for a fact—the power of causing the plane of polarisation to rotate. Now previous to 1845 Faraday had succeeded, both by helices and magnets, in causing the plane of polarisation in solids and liquids, previously neutral, to rotate. If such rotatory power is a proof of molecular dissymmetry, Faraday succeeded in conferring this power upon more than 150 substances. But that they were thus brought any the nearer to vitality it nowise appears.

But we must now pass to an apparently very remote subject, the "vaccines,"—as they have been unhappily named—which Pasteur has devised for certain zymotic diseases. The one basis common to Jenner and to Pasteur is the proposition that a man can have ordinarily certain diseases only once in his lifetime, and that if he recovers he will ordinarily enjoy a complete immunity. Ordinarily, for there appear to be exceptional cases in which a single attack of yellow fever, black plague, smallpox, &c., does not permanently exhaust the susceptibility of the patient. But beyond this fundamental proposition, Jenner and Pasteur diverge completely from each other. Jenner observed, or thought that he had observed, that a disease different from smallpox, and not naturally occurring in man, could, if transferred to the human subject, exhaust his susceptibility for smallpox,—which question has now unfortunately *descended* (not *ascended*, as anti-vaccinationists put it) into the region of politics, and is being discussed in the customary style of agitators. But Pasteur went to work in a totally different manner. He took the infectious matter of splenic fever, and succeeded in *attenuating* it,—that is, in so reducing its malignity that when introduced into a sheep or an ox it did not not prove mortal, but merely occasioned a slight illness. After its recovery the animal thus "vaccinated"—if the very inapproprite term must be used—was proof against the contagion of splenic fever, even if purposely inoculated with the virus in its original unmitigated form.

In the same manner he has dealt with the virus of rabies; he has attenuated it down to such a point that when introduced into the system of dogs it occasioned merely a slight illness, on recovering from which the subjects thus operated upon were found experimentally to be proof against rabies. If this immunity is found enduring, Pasteur will have freed the world from one of the most fearful maladies to which mankind are liable. No reader of these lines is safe, in the streets, in his garden, or even in his own house, against being bitten by some rabid cur, and doomed to a certain and horrible death,—all the more horrible because of the deceitful respite of months which the victim often enjoys. Surely, we repeat, the man who delivers us from this scourge deserves our utmost gratitude.

As an instance of the dangers which Pasteur encountered in his researches on rabies we may quote the following case:—"Not long ago a veterinary surgeon telegraphed to him—'Attack at its height in poodle and bulldog. Come.' . . . The two dogs were rabid to the last degree. The bulldog especially, an enormous creature, howled and foamed in its cage. . . . Two youths threw a cord with a slip-loop over the dog as a lasso is thrown. The animal was caught and drawn to the edge of the cage. There they managed to get hold of him and to secure his jaws; and the dog choking with fury, his eyes bloodshot, and his body convulsed with a violent spasm, was extended upon a table, and held while Pasteur, leaning over his foaming head, *at the distance of a finger's length*, sucked up into a narrow tube some drops of the saliva. . . . Witnessing this formidable *tête-à-tête*, I thought Pasteur grander than I had ever thought him before."

Yet this man, so ready to expose himself to the most fearful danger in the cause of Science and humanity, is so averse to giving needless pain that he utterly eschews "sport,"—the destruction of animals for pastime. Such are the "investigating sneaks," as they are absurdly called by Bestiarians.

Electricity, and its Manner of Working in the Treatment of Disease. A Thesis for the M.D. Degree of the University of Cambridge. By W. E. STEAVENSON, M.D., M.R.C.P., M.R.C.S. Eng., &c. To which is appended an "Inaugural Medical Dissertation on Electricity, for the Degree of Doctor of Medicine of the University of Edinburgh. Written in Latin by Dr. ROBERT STEAVENSON, 1778, with a Translation by the Rev. F. R. STEAVENSON, M.A. London: J. and A. Churchill.

THIS work is not, as we at first feared from the title on the cover, an elementary manual of electricity, but an investigation of a subject as yet very imperfectly understood—the action of electricity upon the animal economy in disease. Curiously enough, the medical application of electricity, instead of having made important advances, has fallen into neglect. As the author remarks,—"The knowledge of many of the wonderful effects derived by treatment with electricity a hundred years ago has now faded into oblivion, and is unknown to the practitioner of the the present day." This is the more to be wondered at and regretted, since the electrical appliances which might now be made available in the healing art are vastly improved and extended. Still more is it to be deplored that the medical applications of this powerful and versatile agent should have fallen so largely into the hands of the quacks: but quackery in its various types is now, for a season, lord of the ascendant.

The author thinks that statical electricity in the form of the positive charge is possibly preferable in functional diseases, such as hysteria and nerve prostration. But where organic changes are present the current, continuous or interrupted, has been found greatly superior.

We find here a mention of some very curious facts. Thus, lunatics "offer an extraordinary amount of resistance to the passage of an electric current." Whether this be due to the abnormal harshness and dryness of the skin (as is often the case) or to some unusual condition of the internal organs is not decided. It is here remarked that "many of the good results of electricity have been unattained and entirely disbelieved in because the current has been passed through the body in a hap-hazard way, often with the patient only holding the handles of some kind of electrical machine, which has produced most uncomfortable sensations and sometimes pain, with very little appreciable effect upon the organ it was wished to influence, and which possibly was situate in some remote part of the body." This is too true: we have heard of the attempt made by a charlatan to decompose a urinary calculus by causing the patient to grasp the handles of the machine with both hands.

As to the vexed question of the identity or non-identity of nerve-force and electricity the author inclines to the negative view. He cites as distinctions that nerve-force travels only at the rate of 200 feet per second, whilst electricity may traverse a wire at the speed of 462,000,000 feet per second; that nerve-force is not conductible along a wire: that cold diminishes the conductivity of nerves for nerve-force, whilst it increases the conductivity of both solids and fluids for electricity; and that the crushing or compression of a nerve destroys its power of transmitting nerve-force. To this it might be added that the nerves are not superior to other animal tissues as conductors of electricity.

It is mentioned that, according to the interesting researches of Dr. Poore, the passage of a continuous current through the muscles, or the nerves supplying them, increases their susceptibility to the stimulus of the will, and also their endurance for voluntary muscular action. "He found that a weight of 17 ozs. could be held out in the hand at right angles to the body for double the time when a continuous current was passed through the arm than when no electricity was used. He also found that the force of voluntary muscular action measured by the dynamometer could be very greatly increased by the passage through the arm of a galvanic current. It was found that galvanism increased the force of the squeeze of his own hand about 11 lbs."

Dr. Steavenson even suggests that racial and national characteristics may be influenced by the electric conditions of climate.

The last passage which space allows us to notice is only too significant. The author refers to a hint which he threw out in a previous thesis on Asthma that "possibly the varying electrical conditions of the atmosphere might explain the seemingly unaccountable conditions which influence and produce an attack of the disease." But he further adds :—" Since then the struggle for existence which young physicians have to maintain has prevented me devoting the time I could have wished to investigate this theory further." To those whose eyes are open this simple sentence is a very handwriting on the wall of that huge sham, our modern civilisation. To those who cannot, or rather will not, see, the interpretation would be useless.

Dr. Steavenson in this thesis does good service by calling the attention of competent and qualified physiologists and physicians to an agency which has been too long abandoned to quacks.

Records of the Geological Survey of India. Vol. XVIII., Part 1, 1885.

This issue contains the Annual Report of the Geological Survey and of the Calcutta Geological Museum for the year 1884.

Mr. R. Bruce Foote contributes notes on the district between the Singareni Coal-field and the Kistna River. He mentions a bed of iron ore of very rich quality situate at the distance of half a mile from the southern boundary of the Singareni Coal-field and near the great limestone beds of Kadapa age.

Concerning the diamond deposits along the left bank of the Kistna, the author is of opinion that this industry is "crushed by the heavy royalty levied and by other absurd restrictions imposed by certain people at court in Hyderabad." He adds that "there is certainly no geological reason why the undisturbed gravels should not be as rich in diamonds as the portions of the same beds explored in past times.

Mr. D. La Touche furnishes a note on coal and limestone in the Doigrung River, Assam. He finds the coal,—at least the sample taken at the outcrop,—very poor in quality, yielding on analysis 48·76 per cent of ash and only 15·10 per cent of fixed carbon. The limestone he thinks sufficient to supply the wants of Upper Assam.

Mr. W. T. Blanford, F.R.S., gives a paper on "Homotaxis, as illustrated from Indian Formations," being a reprint of his address as President of the Geological Section of the British Association, at Montreal.

Second Annual Report of the United States Geological Survey to the Secretary of the Interior, 1880-81. By J. W. Powell. Washington: Government Printing Office.

In this goodly volume we find, among much other interesting matter, an account of the heat-phenomena of the Comstock Lode. The mere fact is well known to all persons interested in Geology, but the explanation is still wanting. It appears that the water which flooded the lower levels of the Gold Hill mines during the past winter had a temperature of 170° F. "This water will cook food and will destroy the human epidermis, so that partial immersion in it is certain death." In spite of ventilation carried out to an extent without precedent elsewhere deaths from mere heat are not uncommon. The air in most parts is very nearly saturated with moisture, and it is very questionable whether it will be possible to push the workings much further down. Depth and temperature seem proportionate, setting aside local divergences, and it would hence seem that the source of heat must lie far below the greatest depth as yet reached, *i.e.*, above 2000 feet. It is calculated that at the depth of 5000 feet boiling water would be reached, whilst in another hot mine, the Rosebridge Colliery, water will not boil above 10,000 feet.

The two theories generally proposed to account for this exceptional temperature are residual volcanic phenomena and the kaolinisation of the felspar contained in the rock, with fixation of water and liberation of heat. In support of this latter supposition it is urged that flooded drifts have been observed to grow hotter. Experiments, however, seem to show that if this process is going on at all it must be at immense depths. Had the heat of the lode been maintained ever since its formation at the expense of the felspars but little undecomposed felspar could remain. The author of the report seems rather to conclude that heat is conveyed to the lode by waters from great depths.

A survey of the mine, with the view of determining the electric phenomena of masses of ore, is suggested. It is not yet decided whether lode-currents will or will not be of practical assistance to the prospector.

As the only plant which seems to flourish in the desert regions is mentioned the common sunflower, "which thrives anywhere from Maine to Arizona, seeming indifferent to the vicissitudes of climate.

On the other hand, on the "High Plateaus," Mr. Lester F. Ward collected in a single season more than 600 plants, the slopes and platforms being resplendent with dense masses of scarlet, white, purple, and yellow flowers.

The Scientific Roll. A Bibliography, Guide, and Index to Climate. By ALEXANDER RAMSAY, F.G.S., &c. London: W. Swan Sonnenschein and Co.

MR. Ramsay has entered upon an ultra-Herculean task. To index up scientific literature, though a most desirable undertaking, would probably demand the entire time of many persons and would probably involve an expenditure of not less than £20,000. We hope the author may succeed in carrying out his plans; but we fear that even the most industrious and energetic man would find himself overwhelmed by the effort to index even biology.

The work before us begins with an essay by A. R. on diurnal periodicity. Then begins the bibliography of meteorology arranged in years from the 13th century down to 1830. Then follows an interesting memoir by Prof. E. Douglas Archibald on the "Connection between Solar Phenomena and Climatic Cycles." The author in concluding suggests that before long we may come to regard the magnetic needle as a sort of meteorological index. The bibliography is then resumed and carried down to 1881.

We next come to a series of general notes on meteorology, extracted from the works mentioned in the bibliography. Then follows an index of meteorological subjects arranged under such heads as Aqueous vapour, Atmosphere, Aurora, Climate, with references to the bibliography.

Then under the heading "The Scientific Enquirer" follow a number of questions on biological subjects.

We have also reports of the proceedings of the Scientific Union, *i. e.*, the Conference of Delegates from Scientific Societies which has latterly been held annually during the meetings of the British Association.

We can only repeat our hope that Mr. Ramsay may live to carry out his vast undertaking.

Fresenius' Quantitative Analysis, Vol. II., Part I. Translated by C. E. Groves, F.R.S. London: J. and A. Churchill.

This portion of the work is devoted to ultimate organic analysis. The present edition,—so far as can be judged from the small portion which is formally before us,—is elaborated with the author's well-known care and comprehensiveness, all such improvements and modifications as have won recognition in practice being introduced. A feature—and not the least meritorious one—of this work is the avoidance of irrelevant speculations. Fresenius wisely holds that a treatise on chemical analysis is by no means the place for the ventilation of structural formulæ.

The Metaphysical Aspect of Natural History. An Address to the Rochester Natural History Society, December 10th, 1884. By Stephen Monckton, M.D., F.R.C.P. London: H. K. Lewis.

From the title of this little work we were in doubt what to expect. With the incursions of Metaphysics into Natural Science we have in general little sympathy. We soon found, however, from the preface that the author's object is to enforce two propositions by no means novel, and of more value to the Natural Theologian than to the Naturalist as such. These are:—

> "1. That there is in Nature an intelligent will force.
> "2. That such intelligent will is the Author and Subject of the Bible."

The second of these propositions is so completely outside our competence that either to assert or to impugn it in our pages would be a grave act of indiscretion. The first involves teleological considerations which are liable to be instantly met by dysteleology, leading to an interminable and, to the Naturalist, fruitless logomachy. We submit that Science has more to do with efficient than with final causes, which Bacon well designated as "vestal virgins."

In the outset of his discourse Dr. Monckton proposes to the student a difficult undertaking:—"It would be an instructive task for a young member of your Society to work up fully the classifications that have prevailed in Botany and Zoology, grasping the views which were associated with each arrangement, and the corrections that became called for and applied as knowledge became at once more accurate and more wide." We doubt if the possible results of such a study could compensate for the time consumed. How is the modern inquirer to realise the limitations of the knowledge of the older naturalists and the influence of their prepossessions?

Our Corner. Vol. V., No. 4.

THIS journal seems to be becoming more exclusively literary and political. There is an account of some "healing miracles" said to have taken place at the chapel of Knock, in Mayo. Nine cases are given, extracted from the list of cures in Archdeacon Kavanagh's diary. The writer's object appears not so much to examine into the reality of these occurrences as to contend that they are equally credible with the "similar wonders related in the Bible."

CORRESPONDENCE.

. The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

HOW NOT TO DO IT.

It is commonly supposed that the Local Government Board is constantly exerting pressure in favour of sanitary improvements, whilst local authorities are recalcitrant, and seek every expedient to delay, if they cannot prevent, the needful reforms. As a striking instance to the contrary I may point to Hendon. The Local Board there resolved upon a scheme for treating their sewage, in October last, and made application to the Local Government Board for power to borrow a sum of money for the undertaking. Before this could be granted a certain Inspector of the Board had to come to Hendon to hold an official inquiry. He happened, however, to be taken ill early in November, and Hendon has still to wait for his recovery before an additional step can be taken. The Board has other Inspectors equally competent to hold the inquiry; but no! No one else may be entrusted with the affair. Surely Rivers' Pollution Bills are utter farces if delays are permitted on such frivolous pretexts.

A Ratepayer.

PSYCHOGRAPHY.

Your contributor, "R. M. N.," would have rendered a great service to the perplexed many if he could have shown how the motive power used in Psychography, and other Spiritualistic manifestations, is procured. We "so-called scientific men," who, in a recent article in "Light," are likened to "very clever members of the canine race," have been under the conviction that the creation either of matter or of energy is exclusively a Divine attribute. Are we, then, to be accused of "arrogance, prejudice, and preconceived opinions" if we hesitate at accepting facts of such a momentous character?

A "SO-CALLED" SCIENTIFIC MAN.

R. R. S., F.C.S.—On examination you will perceive that the matter to which your letter refers is simply an advertisement, and as such, in obedience to the received code of journalistic courtesy, it cannot be discussed in our columns. We should recommend you to forward your criticism to the author in question.

NOTES.

At a meeting of the Pathological Section of the Academy of Medicine in Ireland, it was mentioned that a lioness in the Dublin Zoological Gardens had entirely eaten off her tail, and had then begun to devour one of her paws, when her lamentable condition rendered it necessary to destroy her. Several other instances of self-mutilation in animals, and one in a child, were given.

Dr. A. Penck has recently examined the Pyrenees, and finds that the western extremity of the chain, beyond the valley of the Saison, has never been glaciated. Indirect evidence has been obtained that the eastern portion of the Pyrenees has been repeatedly glaciated on its northern side.

An anonymous writer in "Science" maintains, in explanation of the alleged decay of Science in and about Boston, that "the mental atmosphere of that city has become one of intellectual finish rather than of intellectual earnestness."

A whale, stranded at Luc-sur-Mer ("Moniteur de Calvados"), has been taken to pieces scientifically, the skin and the skeleton being carefully preserved.

"Cosmos les Mondes" gives, under the heading "Physiology," an account of one Achille Barossi, who is said to be able to walk 180 kilometres daily.

Professor Luvini has recently studied "lateral refraction,"—a novel optical fact.

The Sirocco is found to transport nearly 3½ kilos. of iron as fine dust, per 100 million cubic metres of air.

The Bestiarians have made a third attempt to prevent biological research in Oxford, and have been signally defeated.

The world-renowned ruling-machine of the late M. Nobert was exhibited at the last meeting of the Royal Microscopical Society. It has been purchased by Mr. Frank Crisp, one of the Secretaries. The foundation of the machine is the ordinary dividing-engine used in the graduation of circles and sextants: this, by a vast amount of delicate superposed mechanism, is made to rule lines at a very minute but determinable distance; strange to say the lines are not straight ones, but portions of a large arc; the lines, however, not exceeding one-fiftieth of an inch in length, the curvature is not perceptible. The diamonds used for ruling are worked to knife-edges, in some instances ground, in others chipped, but made with such delicacy that microscopic examination fails to detect any serrations: in this and the glass employed would seem to lie the secret of the fine quality of line produced by M. Nobert. The note-book of the inventor accompanies the machine, and in it the performance of each diamond has been recorded, and much useful information that will probably enable the machine to be used. Experts who have examined the machine since it has been in England do not consider the mechanical contrivances the best that could have been devised; but the fact nevertheless remains that Nobert contrived to execute rulings which have not been equalled. The resolution of the nineteenth band, in which the distance of the lines—according to the measurements of Dr. Pigott—is 112·595 to the inch, and formerly supposed to be impracticable, is now accomplished without much difficulty. There is also an adaptation for ruling the longer and comparatively coarser lines for diffraction plates for spectroscopes.

The death of Charles Vance Smith, of Carmarthen, is announced. The deceased was noted for his skill in preparing vegetable tissues for the microscope: his series illustrating the manuals of Sach and Thomé are well known, and are admirable reproductions of the figures in those works, and of immense value to students unable to procure the specimens for themselves.

M. Arnaud has proved that the orange-red colouring-matter of leaves (erythrophyll) is identical with carotine—the colour of the carrot.

We are glad to find that the London Section of the Society of Chemical Industry has completely condemned the New Rivers' Pollution Bill.

We learn that a new Poisons' Bill has been introduced into the House of Lords. As any conceivable measure of this kind will press heavily both upon the industrial arts and upon scientific research, we recommend that it should be opposed in every possible manner.

According to a well-informed French contemporary the excrements of dogs are now collected in Paris and worked up into peptones and powdered extracts of meat!

According to "Reimann's Faerber Zeitung" a cat which had been accidentally imprisoned for six weeks, in the ruins of a woollen factory near Aix la Chapelle, was found alive, though much emaciated, and is likely to recover.

"Science" makes some apposite remarks concerning the ordinary microscopist:—"The direction of his studies is determined not by any natural bond between the objects, but by the common quality of minuteness. Imagine anyone deliberately setting out to study whatever he could cut with a knife. We should pity the man who chopped up the sciences according to the instruments he uses. We cannot be brought to regard anatomy as a department of cutlery, nor can we seriously admit histology as a department of microscopy.

Th. Chandelon ("Ber. Deutsch. Chem. Gesell.") shows that egg-albumen is peptonised by hydrogen peroxide, the intermediate products being almost identical with those produced from albumen during pepsine and trypsine digestion. Hence he suggests that the digestive ferments act by forming hydrogen peroxide.

We are requested to mention that the Royal Society of New South Wales offers its Medal and a prize of £25 for the best Memoir (if of sufficient merit) on each of the following subjects:—

Series V.—To be sent in not later than May 1st, 1886. No. 16. On the Chemistry of Australian Gums and Resins. No. 17. On the Tin Deposits of New South Wales. No. 18. On the Iron Ore Deposits of New South Wales. No. 19. List of the Marine Fauna of Port Jackson, with Notes on Habits, Distribution, &c.

Series VI.—To be sent in not later than May 1st, 1887. No. 20. On the Silver Ore Deposits of New South Wales. No. 21. Origin and occurrence of Auriferous Veins and Associated Minerals. No. 22. Influence of Australian Climate in modifying Diseases. No. 23. Infusoria peculiar to Australia.

Series IV., for May 1st of the present year, comes too late. The subjects are—Anatomy and Life-history of *Echidna* and *Platypus*; Anatomy and Life-history of Australian Mollusks; and Chemical Composition of Products from the Kerosene Shales of New South Wales.

The yearly consumption of ardent spirits in Norway has fallen during the last forty years from 20 litres to between 3 and 4 litres per head. Simultaneously the number of criminals in prison has decreased from 249 to 180 per 100,000. In Belgium the yearly consumption of alcohol has risen during the same time from 8 to 12 litres per head, and the convicted criminals have increased from 269 to 648 per 100,000. Norway has, per 100,000 inhabitants, 3300 paupers, 83 lunatics, and 7 suicides;

Belgium 14,000 paupers, 150 lunatics, and 10 suicides.—*Berliner Tageblatt.*

At a meeting of the Academy of Medicine in Ireland the Rev. Dr. Haughton stated that the "nail-biting habit was, in his experience, confined to men." About twelve years ago we had the opportunity of observing a woman, of about 27 years old, who bit her nails viciously. We learn, from mistresses of schools, that the habit is by no means rare among female children.

With the mere "passage of matter through matter" we are all fairly familar, but the alleged passage of a solid through a solid without any breach of continuity having been occasioned cuts away the very ground from under our feet.

Mr. James Davison ("Journal of Anat. and Physiol.") concludes, from a series of observations, that full light, darkness, and the blue ray have no influence on the hatching of the eggs of the blowfly. Pupation ensued in the dark in fourteen days, in full light in twenty-one to twenty-eight days, and in the blue ray not at all. The mature insects appeared in the light in twenty-three days, but in the dark only in twenty-six days. The specimens reared in the dark were smaller and less highly coloured than those reared in the light. An increase of 21° F. accelerated both the hatching of the eggs and the pupation of the larvæ.

Mr. H. H. Nicholson ("Science") has observed that certain snakes (*Pituophis Sayi*), on receiving the shock of an induction-coil, uttered a cry like that of a young puppy.

The following strange passage is said to have recently been printed in an English medical journal, as from a correspondent:—"When I state that after the death of a dog or person who has been bitten by a poison snake, on post-mortem examination there will be found attached to the liver a snake of the same species as the one that bit the dog or person, and if the dog has been bitten twice there will be two snakes, and in one instance the snake put out its tongue, nobody who has never seen it or heard of it will believe it. Yet such is the fact. This is why a person or dog who has been bitten with a snake feels the influence every year at the time snakes awake up from their dormant state."

"Light" writes:—"So eminent a man and moralist as Dr. Johnson was touched by Queen Anne,"—*i.e.*, as a remedy for scrofula. But he was not cured!

Madame Traube-Mengarini ("Du Bois Reymond's Archiv.") has been studying the functions of the brain of fishes. Not the entire lobi optici are connected with equilibrium and locomotion, but merely a circumscribed spot at their base. Before and behind it are two parts connected with respiration.

"The Medical Press and Circular" has done good service by its exposure of the alleged "faith-healing" operations of the "Salvation Army" in Staffordshire.

M. Dareste has proved, by comparative experiments, that the turning of eggs during incubation is essential to the healthy development of the embryo. Eight eggs kept motionless under an incubator did not yield a single living chick. Eight similar eggs placed under a similar incubator produced six living chicks; the seventh egg, which was opened on the twenty-second day, contained a living, well-formed chick. *Quære:* the origin of the egg-turning instinct in hens during incubation?

Alfred Nehring ("Naturforscher"), on comparing the skulls of pre-historical domestic dogs with those of wolves, finds no essential difference save in the smaller size of the superior canine,—a point in which wolves vary greatly. He considers that the larger races of dogs are descended from the wolf and the smaller from the jackal.

Prof. Campbell Brown, at a meeting of the Liverpool Section of the Society of Chemical Industry, declared his belief that "Examinations would never be able to determine who was the best practical man. They had signally failed to do so in the universities in this country, and probably everywhere else. He believed the system of examinations so enthusiastically carried on at South Kensington was responsible for a great deal of the mistaken energy which had been devoted to this kind of cramming for Science and Art Examinations. But when they looked away from the examinations, and saw what was being done in the way of teaching, they found a very different account. It was not by examinations, but by the teachers looking over the work from day to day and from week to week, and making a report of what was done, that they could pick out the best boy for practical work. In the ordinary examinations a boy might not be very well on the day he had to write his answers. He had known men who were perfectly capable of becoming senior wranglers that could not pass because they had the toothache the night before." The nation is evidently awaking, and then "good night" to the Department.

A spirit is described as saying ("Light") "The butterfly would not recognise in the chrysalis a fellow-creature." The spirit is in error. Male butterflies have been observed keeping guard over a chrysalis from which a female of their own species was likely soon to issue.

Mr. C. W. Irish, C E. (" Kansas City Review ") refutes the contention of Mr. Moore that the Romans had colonised America and left there traces of their language.

Captain S. Bent, in the same journal, shows that the plains and table-lands of Utah, Nevada, and Arizona, owe their barrenness to no accidental or remediable cause, but to immutable laws of Nature.

Mount Roraima, in British Guiana, at the height of 5600 feet above the sea-level, is said to be a perfect garden of orchids.

Says Mr. C. C. Massey (" Light "), " It is always difficult to say where moral unveracity shades off into the inaccuracy which has its origin in defects of intellectual habit or temperament."

Dr. A. Bronold (" Zeitschrift Land Vereins in Bayern ") finds that electricity has a threefold influence upon the growth of plants,—as an illuminant, as decomposing the constituents of the soil, and as ozonising the air. By the joint application of this triple agency to certain ornamental plants and to strawberries he effected growth, strength, and health, exceeding by two or three times that obtained under natural cultivation ; larger size and better development of flowers and fruits, without loss of flavour and odour ; larger seeds, possessing greater germinative power ; more complete assimilation of the plant-food in the soil, and freedom from vermin.

Prof. Holdefleiss (" Der Landwirth ") has observed that beet seed, sown in a flower-pot so placed that the soil was exposed to the electric light, germinated two days earlier than similar seeds without the action of the electric light.

Herr Schöller, in the same journal, testifies to the exceptional luxuriance of beets, in a plot of about 2 square metres, which had been struck by lightning.

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THE
JOURNAL OF SCIENCE.

MAY, 1885.

I. THE LESSON OF THE UNNUCLEATED CELL.

By the AUTHOR OF "SCIENTIFIC MATERIALISM."

"*Death not Universal,*" "*Is Death Universal?*" "*Death and Individuality.*"

> "In Nature everything is distinct, yet nothing defined into absolute independent singleness.—MUIR.

IN the July number of the "Journal of Science," 1882 (p. 401), appeared an article headed "Death not Universal," wherein the writer says "If we want something fairly antithetical to death—*i.e.*, to the conclusion of life—we must find it in the beginning of life, that is in birth; where there is no birth there can be no death." Also, "All animals *may* die, but death is not in all departments of the animal kingdom an inherent absolute necessity. On the contrary, in one of the two primary divisions of the animal kingdom, the Protozoa, it is, though common enough, merely casual, the result of some accident: it may be crushed out of existence, burnt, or poisoned by 'disinfectants' introduced into water, or other fluid which it inhabits. But it has no natural term of life, and . . . cannot be spoken of as old or young." Then follows a comparison between the forms of life of the Metazoa and "the Protozoa." Then is described the fission of the Protozoa, whereby is produced two exactly similar creatures, and "we cannot say that either of them is more mature or more rudimentary than the other," and that there is no analogy between this and other forms of perpetuation. "The process of reproduction must, as far as we can see, be repeated in the same manner for ever. Accidents excepted, they are immortal." That "these frail tiny beings were living not potentially in their ancestors, but really in their own persons, perhaps, in the Laurentian epoch!"

In the February number of this Journal (pp. 68 and 72) appear two articles which are parcel of the same subject. The first, "Is Death Universal?" "In monocellular animals, which propagate by division, the entire bodily substance of the older individuals continues to live in the young individuals into which the former have resolved themselves by the act of fission," "thence Weisman ascribes to the Protozoa immortality." And he argues thus:—"We have an endless series of individuals, each of which is as old as the species itself." "The Metazoa have lost this faculty of endless life. In them the monocellular organisms is restricted to the reproduction cells alone." Möbius differs from this conclusion, and the writer reasserts the position assumed by Weisman.

The second article, "Death and Individuality." C. S. Minot says "the current conceptions of death as a biological phenomenon are very confused and unscientific," and that "the recent publications of Weisman and Goette upon this general topic have increased rather than lessened the existing confusion. In fact these authors fail to make the necessary distinctions between the different kinds of death, the different orders of individuality, and the different forms of reproduction. When speaking of individuality the author says the error of Weisman and Goette is that "they both assume that the death of a single protozoon is equivalent to the death of one of the higher animals." It is to be noted, the latter says, "The death of a unicellular is entirely different from the death of a multicellular individual." Minot further says, "To Huxley we owe the first scientific determination of individuality. . . . Life occurs in cycles of cells: *each cycle comprises all the cells springing from a single impregnated ovum.*" "*All cells are homologous, all cycles are homologous, but individuals are not always homologous*, since an individual may be the whole or any fractional part of a cycle." Thus "the whole of every cycle is homologous with every other whole cycle, no matter whether every cell is a so-called individual, or whether they constitute several individuals (*e.g.*, polyps) or a single one (vertebrates)."

In substance Mr. Minot's arguments are as follows:— That all organisms develope in cycles, and that all species begin their life-history with an impregnated cell, or ovum, or its equivalent.* That sexual reproduction extends to the lowest animated being, although differently manifested in lower forms. This is not the general view. Botanists trace the evolution of sex within the vegetable kingdom, and zoologists less definitely within the animal kingdom: hence sex, the most fundamental and characteristic phenomenon of life, has arisen twice. It is more reasonable to suppose the sexual function exists in the protobionts, neither animal nor vegetable, and produces a body homologous with an impregnated ovum, and that out of this common commencement both the animal and vegetable sex has been evolved. *The essential property of the sexually produced ovum is its power of repeated division, producing a succession of cell generations which together with the original body (ovum) constitute the cycle* (italics mine), even among the Protozoa of the Protophytes.† That all cycles of cells are self-limited (*i.e.*, causes of natural death), our knowledge of which is solely derived from the higher animals.

My experiments show that the growth, at least of the higher animals, gradually diminishes from the birth onwards —*i.e.*, that the cells of a cycle continuously lose their power of division, so that the intervals between two successive divisions gradually increases, involving the ultimate termination of the cycle, the losses going on, not until the cells can no longer divide, but until they exhaust themselves; the series of changes is *senescence*, a continuous process covering the whole period of a cycle of cells. The question then arises whether the same phenomenon occurs with unicellular organisms. In the divisions of the Paramecium it is found, after conjugation, they are at first rapid, then follow at increasing intervals, and would prove that we have here true *senescence*, with its sequel natural death, or the end of the cycle.

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* Haeckel ("Evolution of Man," p. 162, vol. i.) says "All different kinds of cells originally proceeded by differentiation or specialisation from the simple egg cell, and from the homogenous descendants of that egg cell." "Schleiden and Schwann were the first to furnish experiential proofs that all organisms are either simple cells or accumulations (syntheses) of such cells" ("History of Creation," vol. i., p. 98). "Every young ovum has the character of a simple cell formed from a mass of naked protoplasm" ("Embryology," BALFOUR, vol. 1, p. 14). "In its young condition is obviously nothing but a simple cell, and so remains until maturity" (*Ib.*, p. 16). "This is disputed by many biologists who 'hold the ovum to be a compound structure'" (*Ib.*, p. 15).

† (HAECKEL'S "Creation," vol. ii., p. 47.)—Protista cannot be assigned either to the pedigree of the vegetable or that of the animal kingdom. "They show in their external form, in their inner structure, and in all their vital phenomena, such a remarkable mixture of animal and vegetable properties" that they cannot be assigned to either. "Many of these doubtful primary creatures botanists defined as animals, and zoologists as plants," and so the opposite. "All more recent investigations on the lowest organisms have completely effaced, or at the least destroyed, the sharp boundary between the animal and vegetable kingdoms" (p. 48). At p. 49 the distinctive kingdom of the Protista is defined.

Weisman's first intimation was an address delivered before the German Naturforscher Versammlung, September, 1881. He assumes that propagation by simple division may go on for ever ;[*] he does not consider whether the cells form cycles, and whether these need be renewed—so misses the real problem ; he is enchained by a mystical idea of individuality, and reasons as if this rendered direct comparisons legitimate between things essentially different,—*e.g.*, that an individual protozoon is comparable to an individual dog. Bütschli propounds the hypothesis of a *lebensferment*, continually resumed in the Protozoa, which thus is potentially immortal ; he also fails to grasp the true idea whether they form senescent cycles. Cholodowsky assumes natural death is restricted to multicellular animals, but overlooks the only possible homologues among Protozoa. Goette made an advance beyond his predecessors ; he attempted to show that there is a death common to all organisms ; he concludes that death and reproduction are intimately connected. (Mr. Minot says he appears vague and obscure, and to many of his views he cannot assent.) Now if death and reproduction are intimately connected, each cycle before it is completely exhausted must produce the initials of new cycles ; hence the connection in time between maturity, or the approach of death, and sexual reproduction. Hence he arrives at the following hypothesis:—"Originally each cell of a cycle was a distinct individual: the exhaustion of the last cells of a cycle cause them to become sexual bodies, and to conjugate; conjugation renews the power of division in the conjugated individuals, and therewith a new cycle is begun. Subsequently multicellular animals are evolved, and in these the same phenomena occur: but some of the cells have become specially organised, and become incapable of assuming the sexual state; hence when the end of the cycle approaches only a few cells become sexual, and the animal (or plant) is mature. The higher organisms become sexually active only after having grown for a considerable period, because they still preserve the primitive relation. Senility is the *auslösende reiz* of sexual reproduction.

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[*] "Reproduction essentially consists in the separation of a portion of an organism which has the capacity of developing into a form similar to that which gave it origin." The simplest modes occur among the Protozoa, which "may be classified in three groups :—(1) fission ; (2) budding or gemmation ; (3) spore formation. Reproduction in all these ways may take place either subsequently to or in consequence . . . of a process known as conjugation, which consists in the temporary or permanent fusion of two or more individuals, or spontaneously, *i.e.*, independently of any such previous conjugation" ("Comparative Embryology," BALFOUR, pp. 5, 6). "Fission is simply the division of the organism into two similar parts, the nucleus, when present, becoming divided simultaneously with the cell body." "Besides single fission a process of multiple fission may take place, as amongst the Flagellata, where Drysdale and Dallinger have shown that an individual enclosed within a structureless cyst may divide first into two, then into four, and so on" (*Ib.*, p. 6). In gemmation or budding "the separation of the smaller organism from the larger is preceded by a process of growth in the latter, so that in the separation of the bud no essential part of the parent form is removed. Both these processes when incomplete lead to the formations of colonies." Spore formation "does not essentially differ from that by multiple fission. It consists in the breaking up of the organisms into a number (usually very considerable) of portions ; each of which eventually develops into an organism like the parent form." "The two processes may co-exist in a single form,—*e.g.*, the biflagellate monad of Drysdale and Dallinger" (*Ib.*, p. 6).

As the above is the gist of the articles in comment, what are the conclusions to be drawn? that matter in any concrete form is immortal, or that all organisms obey the apparent presentment of Nature—death, or, in another word, mutation. The force of the argument *for* appears to consist in the idea that there are no dead bodies of the Protozoa arising from natural causes, and that therefore they must be immortal; against which it might be urged, they being microscopic creatures, sufficient experience has not been obtained, or that the *débris* (when death arose from natural causes) was resolved in a slight interval into their original gaseous composition. The white corpuscles of the blood are in continual augmentation, which, giving rise to the red, carry on the functions of the organism, and which when exhausted are exhaled; but there are no *débris*, unless blood-poisoning be its synonym.*

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* The literature relating to the corpuscles of the blood is very limited: the fullest account of them I find in Huxley's "Elementary Physiology." The blood corpuscles are so minute that it requires a microscopic power of three or four hundred diameters to detect them. Particles are then seen which constitute the corpuscles of the blood suspended in the *plasma*. They are of two kinds, the colourless and the red; that the red corpuscle is derived from the white "may be regarded as certain," the red corpuscle being simply the nucleus of the white set free by the bursting of its sac or wall. The colourless or white are the larger, the red the most numerous, and so minute that ten millions of them will lie in the space of a square inch; they present the appearance of a flattened disc,—soft, flexible, and elastic bodies,—and readily squeeze through apertures narrower than the diameters of their own bodies, and have no distinct structure. The white differ from them in the extreme irregularity of their form and continuing variation of shape. The reproduction of the red corpuscles appears to be by spore formation. Of the white, owing to the continuous change of shape, the supposition would be that their reproduction was by the process of simple fission. There is no observation to that effect. Haeckel ("History of Creation," vol. i., p. 159) gives an example of blood corpuscles increasing by self-division, the embryo of a stag. Huxley says the origin of the white corpuscle is not determined. "It is probable that

We have seen the proposition of the German philosophers, and also that of Mr. Minot. Another German naturalist, Dr. Möbius, dissents from his brother professors. He asks:—Is the idea of immortality applicable to the Protozoa which propagate by fission? Do they persist as individuals until their life is destroyed by some outward agency?" And answers:—"Adult Protozoa in their fissiparous generation leave no part of their body behind which can die. But they cannot on that account be regarded as immortal, for on fission their individual existence is gradually extinguished, and comes to an end in a moment when the daughter offsets separate from each other. With the conclusion of the process of fission the mother individual ceases to live, but the substance of its body carries on the same specific functions in the effects, and indeed with a rejuvenated susceptibility to external impressions which in the aged individuals had been gradually fainter and fainter, and had finally ceased altogether. Whilst the bodily substance reacts more faintly to outward impressions, there appear in its interior striking movements, which precede the fission of the maternal body, and evidently subserve the rejuvenescence of such substance for its progeny. The retraction of the cilia, the disappearance of the flagella, the rounding off of the body, and its incapsulation before fission, must enfeeble the irritability of the older individuals. The young offshoots begin their individual life with great susceptibility to external impressions, because their bodily substance consists of freshly-located molecules."* He then states that in the

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they are constituent cells of the particular parts of the solid substance of the body which have been detached and carried into the blood." Whilst living and active no notion can be formed of their structure; when killed with acetic acid they seem to be spherical bags, or sacs, with very thin walls, containing in their interior a fluid which is clear or granular, with a spheroidal vesicular body,—nucleus,—in fact a nucleated cell, and, excepting that it is dependent for the conditions of its existence on the *plasma*, it might be an *Amœba*. *Invertebrata* which have true blood corpuscles have only such as resemble the white. The *lancelet*, and very young embryos of all vertebrate animals, have *only* colourless and nucleated corpuscles. All vertebrates the young of which are born from an egg have colourless corpuscles, like those of man, and the red nucleated corpuscles found are simply colourless corpuscles enlarged and coloured. Mammals have both kinds with slight differences in various creatures.—(*Vide* "Blood and Lymph," pp. 58 to 64).

* In the chemical changes called Isomeric compounds we have the same substances with the same constituents, but with intricate molecular changes, constituting distinct opposites—stinks or scents, poisons or innocuous substances; so with the protozoon the molecular change might account for every difficulty but individuality and immortality. It is very possible that all the changes we know in phenomena are the results of molecular re-distribution.—(S. B.)

tenth division the creature has at the most but 1-1024th part of the ancestral body with which it started. The Protozoa consist of one plastide only. Subsequent generations of Protozoa consist therefore more or less of bodily substance which they have individually elaborated, and less and less of ancestral constituents.

"The Protozoa are, like the Metazoa, to be regarded as psychically centralised individuals. In the several psychic centres of the offshoots the former psychic centre of the mother cannot persist, because her individual bodily and spiritual life is extinguished by fission. The Protozoa can therefore, from a psychological view, not be regarded as immortal."

Thus we see that the assumption of the immortality of the Protozoa is founded on another, *viz.*, that the *débris* of dead Protozoa, extinct by senescence or natural death, are not discoverable. It might be asked, has that pertinacious observation which characterised those of Dr. Dallinger and his coadjutor been pursued? In their case six years of unwearied observations were passed before the result was disclosed. Do the blood corpuscles give no hint of the possibility of there being such *débris* as it is contended do not exist? Had Dr. Dallinger's observations been intermittent it is more than probable the final result would not have been observed.

In assuming that the Protozoon is immortal we are at the same time assuming *that matter in a concrete form is constant, and can exist for ever, once formed for ever continuing.* Such an assumption is contrary to all the conclusions of Science; the law of Nature is mutation; nothing consists in its original elements; there are constant inhalations and excretions. Thus of necessity every concrete form is in a state of continual change, and probably in a short period not one atom of the original Protozoon is existing; and, as Möbius truly says, even supposing the original Protozoon had an existence, the repeated divisions would rob the substance of all pretence of individuality. In what, then, does the immortality consist? There can be but one answer: in the life energy whose functional power caused the coalescence of the substance, and presented on the face of Nature the unnucleated cell, that potence from whence all animation ensued. The life energy is exhibited in its power of gathering to itself all substances on which its energy can be exerted, the condensation of the gaseous envelope which surrounds the world of life. The question is rather Cosmic than Biological, and discloses the hidden impulse, that great unity of power, hidden in the silence of the unknown—that great, yet open, secret scattered broadcast over phenomenal Nature awaiting disentanglement. Here the great secret lies continually developing in mutations and transformations.*

When a question is Cosmic it is an embodied Science; no section is then more prominent than another. Biology may claim the solution, but the claim sinks into insignificance when the grand aspects of the Universe are in question. The first presence of life on the Earth, the parent of all its phenomena, are conjunctive; of this Biology may claim to advance its proofs. Had the lichen been unaccompanied by the fungus the bare face of the rock had never been clothed; but long before this era the unnucleated cell was working and in power, for, although we are told that there are no *débris* of the Protozoa,—of these unicellular things,—the *débris* of the monads exist in countless billions;† creatures so small as only to be discerned by the most powerful microscope, yet so vast in number that a single drop of fluid may contain more individuals than there are inhabitants on the face of the Globe. Has Geology nothing to advance against the position that these minute creatures leave no *débris?* Ehrenberg computed that there are sometimes more than a million of these animals in a cubic inch of chalk. It has been demonstrated that rocks which belong to the most ancient epoch of life on earth, sometimes containing strata of vast magnitude, are only so many grave-yards of Infusoria. In Richmond, U.S., "the deposit of microscopic skeletons attains a depth of several hundred yards. In the Tripoli of Bilin, Bohemia, Schleiden calculated a cubic inch contains forty-one millions of animalcules. The schists of Bilin have a surface of 8 or 10 square leagues, and are from 2 to 15 feet thick. The Infusoria enter not alone into the composition of porous rocks, but are met with in silex; red rock salt owes its tinge to microscopic animals, and even the red of the carnelian is due to the presence of Infusoria. Many more are the instances which may be adduced, and so astounding are the inferences that it might almost be asserted that the rocks, inorganic formations, are due to monocellular creatures and their allies. Polyps and sponges have lent their aid. The more deeply the question is examined the more far-reaching is the seeming that all natural phenomena, organic and inorganic, are but the results of the living energy which first concreted and then possessed the unnucleated monad.

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* In cases of descent there are, according to Darwin's theory of descent, "two guiding, and in a certain sense antagonistic, principles, . . . known as the laws of heredity and variation." The first "asserts that the characters of an organism, at all stages of its existence, are reproduced in its descendants at corresponding stages." The second "asserts that offsprings never exactly resemble their parents." "By the common action of these two principles continuous variation from a parent type becomes a possibility, since every acquired variation has a tendency to be inherited. This law "asserts that each organism, in the course of its individual ontogony, repeats the history of its ancestral development."

† The *Monera* are the most ancient primary forms of all organisms without exception (p. 50). "The simple homogeneous little lump of slime or mucus . . . constitutes their entire bodies" (*ib.*), and "are more closely connected with anorgana than with organisms" (p. 52). "In reality every naked simple cell, whether it proceeds from an animal or vegetable body, cannot be distinguished from an independent *Amœba*, ... which is nothing but a simple primary cell, a naked little lump of cell-matter or *plasma*, containing a kernel" (p. 54), "and propagate by division" (p. 55), "and it is evident that it originally arose out of simple *Monera* (*Protamœba*) by the important process of segregation taking place in the homogeneous viscid body,—the differentiation of an inner kernel from the surrounding plasma. By this means the great progress from a simple cytod (without kernel) into a real cell (with kernel) was accomplished" (p. 56).—Haeckel's *History of Creation*, Vol. I.

It must be assumed there is but one law of life. Because the protozoon propagates by division it is said that as there is no birth there can be no death (unless by casualty). Möbius has shown that changes in the body of the creature ensue before fission: no sufficient observation has been shown by which would be excluded the idea of conjunctive generation; nor that the creatures are not hermaphrodite, and have organs of self-impregnation, or that the fission—the resulting reproduction—is due to such action. Excepting that the creatures divide and present a matured living prototype, there is no difference in their multiplication than in that of other creatures; the young of the Vertebrates is in fact an act of fission of the parent perfected by growth, and every after generation: but a perpetuation of the first fission, or birth, and the remotest descendant, is as much the presentment of the original ancestor as that the present protozoon is of its Laurentian parent; life from the egg is also in parallel.

The one thing, so far as organic nature is concerned, is that the immortality is alone of the life energy, for ever existing and for ever acting; exudations and carpaces strew the face of the Globe, and have their presence in the rocks formed from the carcases of those condensations of substances which the life energy has collected and used, and which, when they have served their use, have been thrust aside and become the bones and ribs of inorganic formations, perhaps again to be arrested in their apparent inertia, again to be presented as organic forms, rehabilitated by the ever present and ever active life energy.

There have been many hypotheses of the advent of life on the Earth. Take one: If life was borne to the earth on the fragment of an external world, from whence was the life of the first world acquired? coagulated from the igneous fluid?!! Life is universal throughout the Universe, and its first presentment on earth was exactly the same as that which occurred when the first inhabited orb was struck into being. The only reasonable explanation of the presence of life in this globe is that of vital spontaneity, which may be explained as the fittingness of substances collected by its functional power, and then used for the display of the life energy; and this display of energy is exhibited each moment in time. Spontaneity, whatever it may mean, was doubtless the fact of phenomenal life, law formulated, and that beginning is the continued present. This hypothesis points to that beginning of life from which all the facts of Science converge, immensity everywhere, in the minute and in the gigantic; the "dust of stars" and the minute Infusoria all point to the same conclusion. We do not expect to see the rock become a man, but we do find the beginnings of life in the organless and unnucleated jelly-spot; and in this apparently insignificant beginning we find in that potence the cradle of all animate forms, even of its diadem—man.

If we conceive the cosmic energy to be vitality, the secret of organism would be found in an expansion from the centre; and if, as held, there be but one rigid law which (however diverse in action) rules all phenomena, it is no assumption to say that every particle of substance whose sum constitutes the Universe is, or was, vitally indued, and the law which made the Cosmos a unity is universal; then the diversities we know as inorganic constructions and animate organisms are but differentiated sequences arising from principles and forces instituted and marshalled by law.

We speak of natural law: in this consideration "it is evident that our reason does not only test the work of our own reason, but we also test the agreement of our reason with a work which we are certain our reason did not produce," and "if the laws of our reason did not exist in Nature we should vainly attempt to force them on her; if the laws of Nature did not exist in our reason we should not be able to comprehend them" (Œrsted). "Every phenomenon on analysis shows dependence and mortality, and the invariable in Nature is only discovered by means of conclusions founded on reason" (*Ib.*).

In his work, "The Unity of Nature," the Duke of Argyll says—"So we come to understand that the limits which we see in Nature is that kind of unity which the mind recognises as the results of operations similar to its own; not a unity which consists in mere sameness of material, or in mere identity of composition, or in mere uniformity of structure, but a unity which consists in the subordination of all these to similar aims and to similar principles of action,—that is to say, in like methods of yoking a few elementary forces to the discharge of special functions, and to the production by adjustment of one harmonious whole" (p. 44). "We cannot suppose life to be a substance supported by another, neither can we suppose it to be a chemical element in combination with another. It seems rather like a force or energy which first works up the inorganic materials into the form of protoplasm, and then continues to exert itself through the combination when achieved" (*Ib.*, p. 35).*

Thus it would seem that in the investigations of the problems of Nature we should exercise our reason which finds its correlate in Nature, or it could not exist; for all Nature is homologous and harmonious, and so should be judged the question of the immortality of the Protozoon. As to the suggestion of an immortality from the Laurentian era, it has been remarked "that a Laurentian Protozoon would certainly fill an interesting niche in a biological museum." If the protozoon is undying, such an event should be more than expected. It is more than probable that analogous forms were in existence before the Laurentian formation.

What are the conclusions to be arrived at, and to what do they point, looking at the question as a mere fact of Natural History, or as to its Cosmic relations? It is not to be supposed that vital energy can be moved in a direction not contained within itself; and this direction seems to be multiplication and diffusion, the energy being continually expended, and yet, though self-contained, continually augmented—an end attained by generation and muliplication. The Aphides are a remarkable instance of the generative variations to be found in a single species,—in fact seem to include all the generative and accumulative modes observed by Science. They have fission, gemmation, virginal, generative, are viviparous and oviparous, and what of their *débris* when in natural sources they find their end—a minute white scale, which no imagination could ever conceive to be the carcase of an animal. Again, of their advent, they are said to be oviparous. The first presentment is a glutinous substance, termed "honey dew," which in a few days teems with innumerable living objects,—black Aphides,—and when they subside, where are their carcases? I have seen the creatures in millions, but no appreciable *débris*, and so it may be with the carcases of the Protozoa: crushed Aphides and crushed Protozoa we may see, but these carcases are no continuing objects.

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* "An intelligent appreciation of the various phases of Nature shows how causes and effects are commingled, and by tracing the cause backwards each effect discloses its cause, which is but an effect of a preceding cause, which cause in its endless branches is but the primæval unity out of which the Universe has emerged in the grandeur of its own effect, interlaced with that energy, its maintaining power and support, which could only have arisen through the action of a supreme intelligence."

"The whole existing phenomena are governed by laws, not mere collections of laws, but one undivided whole, wherein one part cannot be considered without the other. They are not the work of a blind necessity (their consonance and order disprove such an assumption), for that in itself is a chimera; they constitute one whole all-embracing and penetrating dominion of reason."

"All laws of existence are laws of reason; not merely an assemblage, but a system of laws: in other words, an arrangement of reason, in which everything viewed in relation to its origin proves itself necessary, and viewed from its results proves itself to be wise. All that takes place is prepared by what precedes, prepares what follows, and is connected with the whole."—*Œrsted.*

The unnucleated cell is the most simple, and at the same time the most concentrated, form of the life energy, as from it spring all the complex forms in which we see the life energy existing. The nucleated cell is the complex form of the life energy; systems of cells grow out of it, and these systems of cells are aggregated life energies: the aggregation of systems of cells in their ultimate energies digresses into the various complicated forms in which life energies are collected (vegetable and animal), each progressing, developing, and growing in insensate degrees; hence in the aggregated systems of cells, each having particular adaptations for the exemplification of particular powers, all of which are the outcome of the unnucleated cell; the perpetuation of the life energy is shown by its differentiations, adaptations, and homologous agglomerations, or so constitute the different forms of phenomenal nature: all, in fact, are but the elongation and diffusion of the life energy condensed in the first unnucleated cell: which, by its functional agglomeration, imprisons and diffuses its environments, and thereby perpetuates itself, making to itself diversities, all growing out of that primal energy discoverable in the simple cell. It is the power we know as the living impulse which in itself contains all forms of life, and out of which all forms of life have diverged. A wonderful support of this conclusion is that the life energy concentrated in the simple cell is found in the blood corpuscles, which multiply by spore formations, and in some cases by fission, and are in fact Protozoa or their allies, and through which systems of cells and cycles of cells derive their nutrition, and form an homologous work when these systems of cells, however different their functions, are concentrated in a single creature.

Simple cells, assumed to be hermaphrodite by an action within themselves, multiply themselves by the three simple reproductive processes. From continuous action a period of senescence arises, and the simple cells, becoming unequal to self interaction, the time arises when the cells are incapable of reproduction by fission, &c. Hence, being incapable of applying all the original forces, another form of application of the life energy ensues. Reproduction being paramount, nucleated cells are formed which multiply themselves in a geometrical ratio; thus a new germ arises, deriving all its force from the original life energy, the new germ resolving into systems and cycles of cells, each cycle containing within itself differing attributes, also differing formative functions, with the functional power of coalescing in cycles with an ingenerating and coalescing principle; hence is gotten singleness of action, directed to a particular purpose, as the production of a plastide, a plant, an animal. Degeneration is but senescence presented in a particular form; the decadence or dying out of a particular species is but the initiatory step to a new formation. The inference to be collected from this is that all organic formations, however diverse, are but the continuation of the vitality contained in the first life-impregnated cell, always reproducing and multiplying itself: hence it follows that vital energy alone is the undying principle of Nature.*

Unicellular or multicellular forms, so far as the vital energy is concerned, are indistinguishable: then necessarily we must have the same life in a single cell as in a cycle of cells; thus vital energy becomes the perpetuation of a single function in continuous excitation, and the multiplication of organic forms, but the accordant life of the simple cell; therefore the unit of life there presented is equal to the whole life phenomena of the world. The question which the world of Science asks is—"Is there more life in the adult man than in the infant, in the horse than in the mouse, in two mice than in one mouse?" The answer appears to be contained above, the only differentiation being the periods of senescence and growth; the application is rather quality than quantity. The life energy being equal to the needs of the creature, it is the same whether it be exhibited in an individual or in a multitude, in a microscopic creature or in an elephant, in a May fly or in a goose.

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* HAECKEL, History of Creation (vol. i., p. 123). "In the animal as well as in the vegetable kingdom, when closely and accurately considered, the monophyletic hypothesis of descent is found to be more satisfactory than the polyphyletic hypothesis.

It is impossible to say that any form of condensed or concentrated matter can be immortal or unchanging; the only immortality which can be conceived is that of the life energy. All forms of matter are gaseous and concentrated only by some active energy, which being removed the concentrations cease, and the compound is resolved into its primitive forms, or is resolved by other forms. We have, through the organic, the inorganic forms of structure, but we have never the originally concentrated forms; there is no individuality in material substances, unless it be in their primitive gaseous state. What is the philosophical conclusion at which we arrive? The first unnucleated cell which was projected in so-called chaos—*i.e.*, the Æther—bore within itself the fecundated principle of all living things. Science shows that all substances are in a continuous state of change, inhalation, and exudation, showing continuous accretions of new substance, and the exudation of exhausted material which is subjected to changes, and is rehabilitated. What, then, becomes of the immortality of the substance of the Protozoa? The immortality of matter, in the sense of unchanged living matter, must be abandoned, for matter without life is an inert mass. We have then to fall back on the life energy of the simple cell, and from it we must adduce not alone the organised forms of life, but also the inorganic, gaseous compounds consolidated through vital energy; and where does this lead us? The whole of the hypotheses of Cosmogony founded on the nebular theory, with fire mists and flaming suns, do not appear to be founded on a purely scientific or logical method.* That the nebular presentments are the initiating steps for the consolidation of Sun Systems is probable, but the condensation of the substance must be wrought by the life energy. It is well to talk of affinities, but there must be something to render these affinities active; something to bring the various substances in contact, to act, as it were, as a filter to crude materials, in order to work them into true combinations. If the life energy be adopted as the active element, we get rid of the flaming fire mist, of flaming photospheres, of atmospheres of flaming hydrogen and nitrogen, of dying-out suns, and the other extraordinary *et cæteras* with which *the scientific mind*, or rather *imagination*, is so apt to indulge. That the Sun is the source of heat and light to this dependent planet we must all admit; but it is not because it is a big fire, but that it is a grand magnetic energy.

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* J. Herschel held it to be probable that the Sun is inhabited. If he held with the fiery nature of its atmosphere, with its burning body beneath, he would hardly have given his authority in furtherance of such an hypothesis.

By the spectrum analysis it is shown that the Sun and the planets (leaving out fixed stars and astral systems) have the same spectrum as the Earth: if so, then concurring conditions must produce the same results, and, as there is an identity of material, it would appear to follow that the same aspect should be presented by each orb. The Earth is the only orb of which we can form a judgment. Where do we find these flaming atmospheres? No doubt to another orb the world would appear luminous, not alone from reflected light, but by the action of its own substances due to magnetic energy augmented by the action of the Sun; the action of its particles adduced by the Earth's evolution would excite and so display its magnetic luminosity. If, then, we find no flaming atmosphere surrounding the world, the materials of its composition being the same as those of the Sun, by what logic are we to assume a flaming sun? when surrounding the world we find the rigidity of cold, and the further its atmosphere is penetrated the intensity of the cold increases. The luminosity of the Sun can be accounted for by magnetic energy (magnetic emanations), increasing in power (over the displays seen on Earth) in accordance with the increase of volume, hence generating an energy which reaches to the utmost limits of his system. The heat engendered by the magnetic energy of the Sun is active on its satellites (they also being magnets), and indues them with the energy existing in the parent nucleus; thus we arrive at a condensation of power and uniformity of action throughout the whole system.

In this view there is no fear that the Sun would exhaust its energy; the same principle which perpetuates the vital energy indued in the unnucleated cell is present in the Sun. The Sun never re-visiting the same place in space, its energy is continually renewed by its environments; the grind of the æther particles encountered in his grand march rehabilitates his energy. If the sun requires 18,000,000 of years to complete his circle, there would be, if he had to go the same round and through the same space, time to renew the energy his circuit had exhausted; but if the Sun and his train be attendant on his primary, then it must be concluded he never enters again the place in space which he had once filled: thus we enlist the universal grind of the whole of the astral systems, and thus the æther would become—as doubtless it is—the storehouse of magnetic power, the grand and never-failing reservoir where the energy of the Universe is stored, which it untiringly gives out; where electrical and magnetical energies occupy, in its vasts, the place which vital energy holds in the world of life.

It is probable that every orb gemming space teems with a great pulsing life,—the tie-bond, not alone of the Sun and his system, but of all suns and their systems,—one grand and homologous whole, floating around an ever-active and untiring centre; the energy of the Universe is the Formulator of Worlds.

Such is the lesson I learn from the unnucleated cell.

II. TELEPHONIC AUDIBILITY.

By the Count O. Reichenbach.

“ENGINEERING” (February 13th, 1885, page 170) reports, “Induction on Telephone Lines”:—“Whatever may be the proper limitation to the term Induction, it is trusted that the same mind which invented the telephone may yet devise some means to annihilate the disturbing influences which limit its application. Mr. W. W. Jaques, one of Professor Bell's coadjutors, has been making investigations upon underground lines, and finds the empirical rule that when *the product* of the static capacity of the line in micro-farads, by its resistance in ohms, is less than 18,000, it is possible to use the telephone for *commercial* purposes; but when this product amounts to between 18,000 and 30,000, then the transmission is imperfect, and nothing can be understood except by skilled operators. No telephonic signals can be transmitted when the product exceeds 30,000.”

Understanding the reasons for an obstacle is a first stage towards its removal. The following, I hope not without interest for physiologists and metaphysicians, might therefore prove suggestive for inventive experimentalists.

Our senses are developed in accord with the organisation of the Earth. We live at her surface, under her atmosphere. When we ascend in it, and density and incumbent weight decrease, audibility declines, for the deepest sounds first, our eye dims; when we submit to pressures of more than one atmosphere the production of high sounds becomes for us more difficult. Both ways the circulation of our blood, and thereby the action of our senses, is upset by abnormal atmospheric pressure.

Eighteen and thirty thousand are round figures: they vary slightly with the acuteness and expertness of the ear of the "operator," by individual and reciprocal geographical position and atmospheric state of connected places, and also by astronomical combinations.

For instance:—The capacity of a conductor is the quantity of electricity with which it is charged by the potential which this charge produces in it. The capacity of an isolated spherical conductor is equal (in numerical value) to its radius.

The mean between the 18,000 and 30,000, between perfect audibility and inaudibility, is 24,000, the figure round which varies the radius into the solar distance of the Earth, the Sun being the electrificator, Sun and Earth standing in electric exchange of store of motive current and electromagnetic resistance. To be brief I omit all secondary influences and combinations.

The Earth is, however, neither a perfect sphere nor a uniform conductor; *capacity* differs and oscillates therefore locally, inside constant amount for the whole Earth. Sound entrusted to the insulated wire, both ways abutting into the atmosphere, is therefore, by the locally changing influences, in the last resort all due to or dependent on the contests and compromises of Earth and Sun, half-way between "commercial" audibility and inaudibility, when the "product" of the factors of induction is equal to the quotient of the radius into the solar distance of the Earth.

The (numerical) value of the ohm is identical with that of a velocity of one quadrant of meridian in one second (theoretically to about 1·062 seconds), such quadrant being—in the mean—about 10,000,000 metres in length. The velocity of sound in *air* is at 15°·22 C., under 760 m.m. pressure, 345 metres in a second; but for the *atmosphere*, in its mean, 396 metres; accelerated and retarded by wind, 6·58 metres (*see* "Journal of Science"—"On Light,"—1883, Nos. 117 and 118); 396 metres being also the rotatory velocity of the surface of the Earth in its mean.

Sound would therefore, to travel from Equator to Pole, use 25,200 ÷ 1·062 more time than the (theoretical) ohm, or 23,730 seconds, which figure, in its abstract form, also expresses the mean of the radius into the solar distance; or the "product" between audibility and non-audibility, of electro-static capacity with electro-magnetic resistance, of induction obstructing telephonic communication.

The Earth's surface presents 2·83 ÷ 3·83 of conducting ocean against 1 ÷ 3·83 of ill-conducting resisting land, ocean and land being both surrounded by the dielectric air permeated by conducting water-stuff, raised, circulated, and precipitated by the contentions and compromises of Sun and Earth.

The same relation, 2·83 : 1, is represented by the division of the quadrant from the Equator to the polar circle or zone, and from there to the pole: circle and zone being the astronomical mean for meteorological conditions; the belt and the region of reversion in the terrestrian rotatory system and constitution, in the circulation of atmosphere, ocean, and vibrating solid.

When the "*product*" is less than the (theoretical) ohm into the time sound would take to travel from the Equator to the polar circle, such time being—

$$7{,}390{,}000 \text{ met.} \div 396 \text{ met.} = 18{,}600 \text{ seconds,}$$

or less than 18,600 ÷ 1·062 = 17,800, telephonic audibility is "commercial" for the sound untrained ear.

When the "*product*" is equal to the quotient of the 1·062 seconds the ohm, into the time sound would take to travel through the distance from Equator to polar circle, *plus* the whole *diameter* of that circle or zone, through 12,610,000 metres, or to—

$$(12{,}610{,}000 \div 396) \div 1{\cdot}062 = 30{,}000,$$

audibility is absolutely at an end.

The solution of the problem would therefore consist in preventing the "product" from becoming the equivalent of absolute polar reversion.

An additional remark might be useful for the appreciation of the true nature of electricity and of molecular physics.

A farad is a quantity founded on the reciprocity of natural bases, but affected by slight defects originating from the length of a second as a measure of time, connected with an original defect of the meter as measure of the length of the mean terrestrial quadrant. Amending these defects we have—

The *capacity* of the Earth in static measure is equal to its radius, $6{\cdot}66 \times 10^8$, which, dividing by v^2, to reduce to magnetic measure, brings as quotient of the capacity of the Earth into that of the farad, 1407. The farad being one million micro-farads we have—

$$1407 \times (666 \times 1{\cdot}062) = \text{such million.}$$

But 666 is one-half the mass of the air into that of the water of the ocean, or of the mass of the atmosphere into that of the salt ocean, or half the mean centrifugality of the Earth at its surface, and a figure very remarkable in many respects. (*See* "On some Properties of the Earth.")

III. HOW, WHEN, AND WHERE IS SEWAGE INJURIOUS?

By J. W. Slater.

BEFORE entering upon these questions I may, perhaps, be asked what is here meant by "injury" or "nuisance"? In my opinion these terms may fairly be taken in a wider sense than is usually done. Judge McCarter, in trying the Newark case of river-pollution, ruled that it was not necessary for the offensive matter complained of to be present in actually poisonous quantity in order to constitute a punishable nuisance. "It is sufficient if it render the water offensive or disagreeable to the taste or smell." Whether this decision be sound law I cannot presume to say, but it is assuredly sound common sense. It is not enough to contend that some particular matter poured into the streams, allowed to diffuse itself into the air or to soak into the ground, does not directly and palpably cause some definite form of disease, or prevent the successful carrying on of some trade or business. If it occasions discomfort to persons living near,—if it offends their senses of sight or smell,—the public have surely a full and indisputable right to complain, and to demand the legislative suppression of the mischief. My definition of "nuisance" is therefore wider than that too often accepted. I should include under the term any matter, whether solid, liquid, or gaseous, which is in itself injurious to health, or which may become so in contact with other substances, whether the latter be in themselves hurtful or not; further, any matter which—though not demonstrably poisonous or hurtful—is offensive to the senses.

There are, of course, certain limitations to be kept in view. Solid, non-volatile matter on private premises cannot be regarded as a nuisance as long as it can neither contaminate the air nor be washed into rivers and water-courses, or out on to public roads or the land of other persons.

Sewage contains, or rather consists of, to a great degree, liquid or at least soluble matter, and, being liable to rapid chemical changes, it gives off volatile products—gases and vapours—in abundance. These gases and vapours are highly offensive to the sense of smell, and if not directly poisonous, as is still often maintained, they lower the vital tone of persons who habitually respire air with which they are mixed. The real danger of sewage, and of water to which it has been added, is that it often—if not always—contains minute living organisms, bacilli, &c., some of which are found to be causally connected with infectious diseases. These tiny organisms, named collectively "microbia," are apt to increase and multiply in the water of rivers, wells, or pools into which sewage finds its way. The water is thus rendered unfit for consumption by human beings, or even by cattle. It may produce sickness and death even if used, *e.g.*, for rinsing out milk-pails, washing cooking-utensils, &c.

It may be urged in opposition that there are places, many of which I know, where the only water available for domestic consumption is drawn from shallow wells, separated from cesspools by a few yards of chalk, gravel, or other porous subsoil; yet the general standard of health in the district remains good.

To this I reply that the residents of such neighbourhoods have, by a process of "natural selection," become inured to the effects of polluted waters, whilst a stranger coming to live in such localities is often seriously affected. But, above all, the health of a population using polluted waters depends on what is commonly called accident. If a single case of typhoid fever, dysentery, or cholera is introduced into such a district, the disease spreads on all sides and commits sad havoc. Thus persons who drink polluted waters hold their health or their lives at the mercy of chance.

But the microbia of contaminated waters find their way also into the air, and may be inhaled with it. In every polluted river fermentation is constantly going on. If any-one carefully watches the Aire at Leeds, the Kelvin Water at Glasgow, the Irwell at Manchester, &c., he will see—especially if the day is warm and the barometer low—bubbles rise to the surface and burst. These bubbles consist of sewage-gas, compounds generally of carbon and hydrogen, with more or less sulphur. But in bursting they carry up with them the disease-germs or microbia above-mentioned, which thus become diffused in the air. Whether these microbia are also carried up into the air when polluted waters evaporate quietly, without the escape of bubbles, has been disputed, but may now be regarded as experimentally demonstrated.

There are, of course, cases where the volume of the sewage poured into a river may be very trifling compared with that of the river itself. Even London could not suffice to pollute the Amazon. But most of the great cities of the modern world discharge their refuse into comparatively small streams.

Seeing, then, that sewage is in the wrong place if poured into waters, we have to ask how does it behave on the land? It is then spread out over a larger area than when it flows in a sewer or a river, and necessarily exposes a larger surface to evaporation. However porous the soil, and however complete the drainage, a quantity of the evil-smelling liquid rises up into the air, carrying with it disease-germs if such are present. It will be found that if water is allowed to flow, however gently, over the surface of dry soil, bubbles are formed and burst. Thus, whenever sewage is turned on to land after an interval, disease-germs will be carried into the air, just as in the case of the bubbles which form on a polluted river. Further, the putrescent matter and disease-germs will be absorbed by two-winged flies, and distributed over the food and the persons of human beings.

Summing up this part of the subject, it may be safely asserted that sewage is harmful and offensive by its odour and its appearance, and especially by its affording a pabulum and breeding-ground for disease-germs. It is offensive in the water-courses and rivers by rendering the water unfit for human consumption, and for all delicate manufacturing processes. This last point is too often overlooked. It may seem a convenience to the manufacturer to discharge his waste waters into the river, but by so doing he renders it of little use, save as a sewer, to all establishments situate lower down the stream. The sewage even of a residential town, except in very small proportions, unfits a river for use in bleach-, dye-, print-, or colour-works.

The question has been raised by a pseudonymous writer in "Ashore or Afloat" whether sewage is really detrimental to fish? We must here, in the first place, remember that there are fish and fish. Not all species are alike in the conditions under which they can subsist, or flourish. But one point, at least, is analytically demonstrated. The greater the proportion of organic pollution in a stream, the smaller is the percentage of free oxygen in solution, such oxygen serving to oxidise—in other words, to burn up—the impurities, and proving insufficient. Again, we know that certain fishes, *e.g.*, the trout, can live only in well-aërated, highly oxygenated waters. Putting these two considerations together we can have little hesitation in pronouncing sewage-pollution as at least one of the causes which have tended to reduce the fish in our rivers. That in many cases, such as those of the Thames and the Clyde, other causes are at work, and especially steam navigation, is highly probable.

We have now to consider what are the compounds or principles which make sewage different from ordinary water and render it unfit for domestic purposes—drinking, cooking, washing, bathing, &c., and for the use of cattle?

Foremost come the compounds of nitrogen. These are of four kinds. There is nitrogen in organic compounds—spoken of by analysts as "organic nitrogen," or "albumenoid ammonia." Such substances are albumen, gelatine, and, in general, all the complex liquid or semi-liquid bodies of animal origin. These bodies are introduced into the sewage in the shape of blood, urine, pus, mucus, half-digested animal food, as well as by certain vegetable products. All these substances pass very readily into intense putrefaction, and are not only exceedingly offensive, but serve as nutriment for those low forms of animal and vegetable life (microbia) which have been already mentioned as especially dangerous.

The second state is urea, which forms a very large part of the solids held in solution in urine. Urea is not dangerous in itself, and in contact with a ferment which is never absent in sewage it is resolved into carbonate of ammonia. Urea, in sewage, may, therefore, be regarded as a mere transition compound.

The third and fourth states in which nitrogen occurs in sewage are as ammonia and as nitric and nitrous acids, the two latter either in combination with the ammonia or the potash and soda, forming nitrates and nitrites.

Ammonia with its salts, and the nitrates and nitrites, even in the largest proportion in which they can occur in sewage, are harmless in themselves; but, like organic nitrogen, they afford nourishment for microbia. Moreover, these three forms, organic nitrogen, ammonia, and the nitrates, are constantly passing and repassing into each other. Growing fungi, and other plants, convert ammonia and the nitrates and nitrites into organic compounds of oxygen. The only way to make any water absolutely incapable of nourishing low forms of life, is to keep it free from combined nitrogen in every shape and state. But with waters exposed to the air this, in the absolute sense of the words, is impracticable.

Phosphoric acid is another ingredient introduced into water by pollution with the excrements of animals, or with decomposing organic matter. It is not an absolute proof of the presence of such pollution, since natural waters, on careful examination, may be found to contain it in very small quantity.

It is, in itself, not merely harmless, but in most cases, doubtless, beneficial. Yet here, again, it may be an indirect source of danger by favouring the multiplication of microbia.

Much the same may be said of potash. It is noteworthy that the three constituents, combined nitrogen, phosphoric acid, and potash, which are most valuable on the land as being necessary to the growth of our food-crops, should be most dangerous in the water as fostering the growth of disease-germs. One and the same kind of matter, accordingly as it is in the right or the wrong place, becomes the source of life or of death.

Common salt (sodium chloride) is more largely present in sewage than in normal natural waters. It is, of course, harmless to human life, even in greater proportions than it is ever known to occur in sewage. But it tells a tale of animal pollution. If in water there is more than 1 grain of chlorine per gallon (= nearly $1\frac{3}{4}$ grain common salt) we have strong reason to suspect that sewage, or, at least, the blood or the urine of animals, has found its way into the river in quantity.

There are, of course, exceptions when salt springs or beds of saliferous minerals occur in the district, or if aluminium, iron, tin, &c., chlorides have been introduced by industrial waste waters. These latter, however, rarely find their way into a stream unaccompanied by sewage in the strict sense of the term.

The absence of chlorine (common salt), say in very trifling quantity, may be accepted as a proof that a stream is free from *animal* pollution, but not necessarily that it is a safe drinking water.

Soluble compounds of sulphur, especially hydrogen sulphide (commonly known as sulphuretted hydrogen), ammonium sulphide, &c., are very generally present in sewage if at all stale, and are the main cause of its evil odour, though not always of its worst effects.

These sulphur-compounds are derived from the solid excrements of men and cattle who feed largely upon cabbages, turnips, and other vegetables containing sulphur, or from the water in which such vegetables have been boiled.

Sulphuretted hydrogen is also formed in abundance when organic matter undergoes decomposition in presence of sulphates, such as gypsum. This, I remark in passing, is a reason against the use of gypsum (sulphate of lime or calcium sulphate) in any form, in the treatment of sewage.

I know an instance of gypsum having been added to sewage-mud in order to aid in solidifying it. Sulphuretted hydrogen was given off in such torrents that the men employed suffered from temporary blindness,—a well-known effect of this offensive gas.

Volatile compounds of phosphorus (hydrogen phosphide, phosphuretted hydrogen) have been popularly supposed to be given off by sewage and sewage deposits. I know of no analytical evidence in proof of this notion, and consider it as a mere freak of the imagination.

Marsh-gas (light carburetted hydrogen or methane) is formed in abundance in stale sewage, as in sewers with too small a gradient, in ill-managed subsidence-tanks, and in accumulations of sewage-mud where decomposition is not arrested by proper chemical agents. If such deposits are stirred up and if a light is held over them the bubbles of gas ignite and burn with a very pale flame. Marsh-gas has no specially injurious action on the animal system, except when in such quantities as to exclude oxygen.

Carbonic acid (carbon dinoxide) is another gaseous product of the decomposition of sewage and sewage mud, and is given off mingled with methane. Workmen have been suffocated by this mixture in ill-ventilated sewers and other under-ground passages.

A gas invariably present in natural waters, as invariably absent in sewage, and found only in an exceptionally small proportion in polluted rivers, is free, gaseous oxygen. In sewage it is consumed by acting upon the organic matter. This negative feature of sewage and of polluted streams accounts for no small part of their injurious action upon the higher aquatic plants and animals.

As regards hardness (*i.e.*, the presence of salts of lime and magnesia), sewage differs little from the water supply of the district. It is usually a little softer on account of the presence of small quantities of soap and washing-soda, and of the introduction of a considerable bulk of rain-water.

The sewage of a residential town has generally an alkaline reaction; that of a manufacturing town may be slightly acid from various kinds of industrial refuse.

It will be at once seen on considering the extreme complexity of sewage, and the unstable character of most of its components, that as it flows it must be continually changing its character; that a specimen taken in the heart of a town will differ greatly in its chemical properties and in its physiological action from another specimen which has travelled along the sewers for the distance, say of two miles. These changes are most rapid and decisive where, as in certain manufacturing towns, the sewage has a temperature of 60° to 70° Fahr. It is needless to say that organic matter suspended or dissolved in water at this temperature must undergo very rapid fermentations and other decompositions. Wherever the sewers are open, as at the grids or ventilation-holes, clouds of steam rise up, carrying with them a very sickening odour.

Here, I may remark, is a serious flaw in the water-carriage of sewage, as at present carried on. If there are no ventilators the sewage-gas is liable, under certain very possible circumstances, to be forced back into the houses, overcoming the valves of the sinks and water-closets.

If there are ventilators of the ordinary kind, *i.e.*, gratings or trap-doors, along the streets, all the passers by are forced to inhale the fumes. In some towns, *e.g.*, in many parts of London, these trap-doors are constructed in the footways, and are opened for a certain time daily to reduce the pressure within. At such times it is a common sight to see a small crowd collect around the opening, craning out their necks as if determined to lose no chance of inhaling the vile fumes!

So far I have been speaking of the ingredients of sewage found to be hurtful to men or other animals living near them. But as far as fish and other animals living in the waters are concerned, several other impurities found in sewage and in polluted rivers must not be forgotten. Foremost come, perhaps, solutions of free chlorine and of the hypochlorites, such as bleaching-lime and bleaching-soda. When these liquids find their way into a river the fish are destroyed far and wide. The surface of the Medway, at Maidstone, is sometimes covered with their dead bodies to such an extent that the smell given off is exceedingly offensive.

Of sulphur-compounds, which are also deadly to fish, I have already spoken.

Lime, in its caustic state (quick-lime, slacked lime, lime-water), is well known as a fish destroyer. Its use has for ages been well known to poachers. Its application in the precipitation of sewage and the attendant dangers are too often overlooked. Even neutral salts, such as the sulphate of soda, the chloride of calcium, &c., if by any mischance they escape into a stream, may prove very destructive to fish, though in large rivers the quantity is rarely sufficient.

We have next to consider what constituents of sewage, if any, are hurtful to plants. In the recent sewage of a residential town there is nothing in the least hurtful to any of our cultivated plants, unless it is either supplied in too large a quantity or that it is too strong. Very few plants can bear repeated waterings with undiluted urine.

But in the sewage of manufacturing towns there are abundance of constituents which, irrespective of quantity, destroy or injure trees, crops, &c., and have further a sterilising effect upon the soil. As such must be mentioned waste bleaching-liquors, most sulphur-compounds, sulphuric and hydrochloric acids, solutions of alumina, iron (especially its proto- or ferrous salts), tin, lead, zinc, chrome, manganese, &c. Further, waters containing tannin, gallic acid, many coal-tar products, &c.

Thus, the waste waters of paper mills, bleach, dye, print, and chemical works, metallurgical establishments, especially places where wire is "pickled," and where the manufacture of tin or terne-plates is carried on. On the other hand, the waste waters of soaperies, glue and gelatine works, and some other establishments, are not to be feared. It will be at once seen that the profitable disposal of waters injurious to vegetation is an exceedingly difficult task, and that here "irrigation" is at once excluded.

IV. THE DISTINCTION BETWEEN ANIMALS AND VEGETABLES.

If we examine the Comtean classification of the sciences, we find it laid down that each member of the hierarchy, whilst depending for its methods, and sometimes even for its doctrines upon those preceding it, is independent of those which succeed it. Thus, according to this view, *e.g.*, chemistry is dependent upon physics and astronomy, but has nothing to learn from biology or from sociology. Physics is in like manner assumed to involve astronomy (and, of course, mathematics), but to have no need of chemistry and biology. That this classification, like every other mere linear arrangement of things classifiable, has failed to give satisfaction to the careful inquirer is a fact open and palpable. But two instances of its departure from the truth are so striking, and at the same time so important in their teachings and in their results, that we must give up a few minutes to their special consideration.

The older and better known of these instances is at once suggested by the mere mention of the spectroscope. Here is an instrument which can be rightly understood and used only by persons conversant with physics and with chemistry. Yet this instrument is now recognised as one of the ordinary working tools of the astronomer. By its aid he studies not merely the temperature and the composition of the heavenly bodies, but even obtains information as to their movements. He is thus compelled to be a physicist and a chemist if he is to use the instrument aright.

Our second instance has come under public consideration more recently, and still presents unexplained phases not a few. We need merely mention the name of Pasteur to remind our readers that a number of important chemical decompositions and other changes which a little while ago were classified as "catalytic" are now traced to the action of "figured ferments." These ferments are living beings reproducing their like by spores or germs and "breeding true" as decidedly as does an oak or a whale. Their vital activity is not merely found indispensable in the conversion of sugars into alcohol, vinegar, &c. They are required to break up dead animal and vegetable matter into simpler compounds, but even such processes as nitrification are now shown to depend on the presence of these microbia. Hence we can no longer say, as does G. H. Lewes, in expounding Comte:* "That the physiologist could not create his science without the aid of chemistry lies in the very nature of physiology; but the chemist can and does create chemistry without the aid of the physiologist." The latter clause of this sentence is now manifest as an error. The causes of a number of important chemical phenomena are not merely organic but vital, and to understand them we must take vital action into account. How many chemical reactions may be occasioned, or at least modified, by the interference of living microscopic organisms has yet to be traced out.

But our object is not to show the untrustworthiness of the Comtean,—or, indeed, of any linear classification of the sciences,—nor even to discuss the chemical action of microbia. This subject will in all probability soon have but too many expounders, and we shall have every change, chemical, physiological, pathological, perhaps even psychical, ascribed to "germs." We wish to call attention to a proposal recently made to base the distinction between animals and plants upon a chemical consideration. We know that all the characteristics upon which an abrupt boundary line between the two great organic kingdoms was founded in days by-gone have faded into indistinctness.

We were, therefore, more surprised than edified to hear of the suggestion to which we refer. In a paper read before the Chemical Society, on February 5th, Professor E. Frankland defined plants as "organisms performing synthetical functions, or such in which these functions are greatly predominant, animals as organisms performing analytical functions, or such in which these functions greatly predominate." On the strength of this single consideration, he ventured to refer the microbia, such as bacteria and bacilli, to the animal kingdom, inasmuch as their life "essentially depends upon the taking asunder more or less complex compounds, resolving them into simpler compounds at the expense of potential energy."

A biological classification professedly founded upon a single antithetical distinction is rarely, if ever, happy, and seems to us, indeed, to be utterly unscientific. If the functions effected by bacilli are in all cases analytical rather than synthetic the correct inference, as, at least, it seems to us, would be, not that they and their allies are animals, but rather that the alleged distinction is of no value, since it leads to a palpable error.

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* Comte's Philosophy of the Sciences, by G. H. Lewes, p. 133.

A palpable error, we say, because, as was pointed out by Professor Burdon Sanderson and Professor E. Ray Lankester, the morphology of the bacteria, &c., and their relations to other organisms identify them with plants. As such, they are accordingly recognised by botanists and zoologists. It has, indeed, been suggested that they might be viewed as morphologically plants but physiologically animals, a supposition which, if verified, would place these beings in an intermediate kingdom, having certain relations both to plants and to animals.

But it may be serviceable to examine further into the definitions for " plant " and " animal " proposed by Professor Frankland. Let us look at the relations of plants and animals to the atmosphere in virtue of which they are commonly pronounced mutually complementary, the one class compensating for the work of the other. The vast majority of plants, as it has long been known, take into their system the carbonic acid of the atmosphere—a compound—and decompose it, exhaling the free oxygen and retaining the carbon. This is surely an analytical process. The vast majority of animals, on the contrary, take into their lungs, gills, or tracheæ free oxygen, and convert it in their bodies into the compound, carbonic acid. This seems to us a synthetic operation.

It is, indeed, held that plants feed upon inorganic matters or upon organisms which have been decomposed into such substances as ammonia, nitrogen acids, &c., whilst animals require to feed upon organic matter. Hence would follow the inference that the plant has the power of building up the complex molecules needed for its life and growth. But we find that the carnivorous plants, which are far more numerous than it is commonly supposed (and some of which even prey upon vertebrate animals), feed like animals upon ready-made albumenoid matter, and seem to require it if they are to flourish. Hence we may fairly infer that they have not the power of forming such matters synthetically in a sufficient degree. Here, therefore, we find no absolute distinction between plants and animals.

Again, Engelmann has found animals—Vorticellæ—which decompose carbonic acid and assimilate its carbon by means of a chlorophyll, forming part and parcel of their own living structure. Surely these cases are enough to break down Professor Frankland's definition of plants and animals. An undoubted plant we see may have, partially at least, to subsist upon highly complex organic matter, and an undoubted animal may be able to assimilate carbon from the carbonic acid of the atmosphere. Now rules which admit of exceptions are not Nature's rules and cannot serve as the basis of class distinctions.

It may further be asked if animals "require to have nitrogen presented to them in an albumenoid form," as was remarked in the discussion which followed upon the reading of Professor Frankland's paper, how it comes that bacilli could live upon urea, which is certainly not an albumenoid?

Professor Frankland's paper, in short, though in other respects of great value, must be regarded as containing an attempt to revive an arbitrary and fast-fading distinction.

There is, in all sober sadness, one reason why the classification of bacteria, &c., as animals is gravely to be deprecated. At present, being considered as plants, they have *no rights.* Neither in Birmingham nor in Edinburgh is it yet contended that plants have "equal rights which are in no case to be hastily and unfairly set aside." Whether increasing insanity or semi-insanity may not some day lead to a "movement" for the emancipation of plants we cannot foresee. But in the meantime we are at full liberty to experiment upon bacteria, and to devise means for their destruction, without being denounced by fanatics as monsters of cruelty, "investigating sneaks," and the like, or being haled before a police-court, as was Professor Ferrier. Should, however, Professor Frankland's definition be accepted, this immunity may cease; and even the simple act of filtering polluted water over the *banal* spongy iron, may be pronounced "violationism," or an "orgie of diabolism."

V. THE PRE-HISTORICAL EXISTENCE OF THE HORSE IN EUROPE.

By Alf. Nehring.

In a memoir read before the Gesellschaft Naturforschender Freunde, of Berlin, and reproduced in their Transactions and in the "Naturforscher," the author discusses the existence of the horse in Europe in pre-historical times. He rejects the common supposition that this animal is of purely Asiatic origin and has been introduced by man from its original home in the steppes. This view is, as he shows, absolutely contradictory to the results which have been latterly attained by palæontologists and archæologists.

As far back as the Middle Tertiary times Europe possessed horse-like animals (*Ancitherium*, and subsequently *Hipparion*), and although the connection between the present horse and these horse-like animals of the Tertiaries is still called in question by many, it is absolutely certain that since the beginning of the Diluvial period Europe has been inhabited by wild horses, which must be zoologically referred to *Equus caballus*, and which cannot be specifically distinguished from the domestic horse of the day.

We find the fossil remains of horses in most deposits which have been formed in Europe since the end of the Tertiary period. We find them in pre-glacial strata: we find them in those deposits of the Glacial epoch which were formed at some distance from the glaciers,—*i.e.*, districts where the existence of the horse was possible during such unfavourable circumstances; we find equine remains very numerously in post-glacial beds (*e.g.*, in the Loess, in many caverns, &c.); and we find them, though less numerous, in certain peat-moors, among the "pile-buildings," and in numerous pre-historical burial-places. In short, the existence of horses in Europe—and especially in Central Europe—can be demonstrated as continuous for the entire time from the beginning of the Diluvial period to the present day.

In favour of the ordinary view that the horse is of Asiatic origin, we find it urged that it is an inhabitant of the steppes, and cannot have been aboriginal in Europe, covered as it then was with mighty primeval forests.

In reply Nehring admits that, in the days of Cæsar and Tacitus, the modern cultivated countries of Central and Western Europe were covered with vast forests and extended swamps,—a fact established not merely by historical testimony, but by the remains of the Flora and Fauna, though the ancient forests and morasses are often supposed to have been more extended than was really the case. But those so-called primeval forests have not existed always. During the Diluvial period, and especially during the Glacial epoch, there occurred for thousands of years a widespread limitation of the forests. Towards the end of the Ice Age, and in the first portions of the post-glacial time, there existed in Central Europe extensive steppe-like regions, covered only with grass and herbs. Not until towards the end of the Diluvial Age did the forest again occupy Germany.

Those thinly-wooded, steppe-like, districts of the Diluvial Age were the resort of many thousands of wild horses, as may be seen from the vast quantity of fossil horse-bones which have been everywhere found in the corresponding deposits of Central Europe. This diluvial wild horse was a strong-boned, thick-headed, middle-sized animal, of about 1½ metres in height. It served the then inhabitants of our regions purely as an object of the chase.

Subsequently, as the diluvial steppe-regions of Central Europe were more and more restricted by the advance of the forest and their peculiar fauna was driven eastwards, the majority of these wild horses also withdrew towards the steppes of the East. Only in the open spaces, which even during the greatest extension of the forests remained in the shape of meadows, heaths, and swampy hollows, there remained wild-horses during the pre-historical Forest Age. But their number was far smaller than it had been previously, and their fossil bones show that the climate and the other conditions of existence were unfavourable. Most of the horses of the Forest Age, whose remains we find in the North German moors, in certain "pile-villages," in the circular pits of Oldenburg, &c., were small, thin-boned animals, from 1·25 to 1·35 metres in height, and, in comparison with the steppe horses of the Diluvial Age, they may be considered as weak and degenerate.

It might, indeed, be asserted that this small, thin-boned horse is the representative of another race of subsequent introduction, having nothing to do with the steppe horse. I am not of this opinion. From the materials before me I am in a position to prove that the horses in our regions underwent a progressive degeneration in size and strength from the Diluvial period down to the age of the Germanic forests.

The causes of such degeneration may be seen, on the one hand, and principally in the damp forest climate, unfavourable to the health of horses, and in the decrease of the pasture lands necessary for their existence; and, on the other hand, in the action of the gradually increasing domestication of the horse by man.

The beginnings of domestication in most animals are accompanied by a certain degradation. So long as man stands at a low stage of culture he uses up (to borrow a French expression, *il exploite*) the animals which he brings under his yoke, and deteriorates their conditions of existence. He restricts their liberty; he uses their strength often beyond a permissible degree; he deprives the young of a portion of their mother's milk; he weans them too early, and in propagation he compels them to prolonged in-breeding. All this, and much more, gives rise to a degeneration which is shown not merely in the outward appearance of the animals, but even in the skeleton. Not until man has advanced so far in cultivation that he bestows upon his domesticated animals the necessary care as dictated by a sound appreciation of the factors essential to a sound development of each species, and when besides the animals themselves have become accustomed in the course of many generations to the changed mode of life due to domesticity, do the bodies of tame animals again become larger and stronger, so that they may often exceed the mean stature and strength of their wild forefathers.

This may be proved from the history of the horse, as well as from that of other domestic species. But it must not be inferred that all the horses now existing in Europe can be traced to the wild horse of the Diluvial epoch. Such a contention would be easily refuted. It is certain that foreign horses were brought into Central and Western Europe, in part from Central Asia and in part from the Mediterranean lands. This was effected both in prehistorical and historical times, by wandering tribes and by commerce. Especially the so-called Oriental horse has been used in the last centuries for breeding a superior class of horses,—especially saddle-horses,—and has impressed a new type upon an essential portion of our present race of horses.

But it is certain to all who do not absolutely ignore facts that Asia is not the exclusive home of the horse. Europe has for ages untold possessed horses, wild at first, but afterwards in part domesticated. The descendants of these tame horses bred on European soil may still be seen in the so-called "common horse" where not modified by crossing with foreign blood.

VI. PERIODICITY IN THE ORGANIC WORLD: A PROLEGOMENON.

NOW the Periodic Law has been applied to the classification of minerals, it seems natural to raise the question whether any harmony, not indeed identical, but at least approximately analogous, can be traced in the animal and vegetable kingdoms ? We do not, of course, refer to that well-known periodicity which may be found morphologically in the recurrence of certain forms and relations in the individual being, nor yet to the alternate or cyclical repetition of phenomena in its development and life. In these directions much has been already learnt, and more remains as yet unlearnt. But we have in view taxonomy,—the classification of organic forms. We venture to ask whether, on viewing, *e. g.*, the animal kingdom as a whole, we can trace in it anything which shall remind us, however remotely, of the Newlands-Mendelejeff classification of the chemical elements. Do we find any phenomenon repeating itself at definite intervals ? Two *a priori* objections will here at once suggest themselves. It may be said that the very attempt to search out such correspondences in the organic world is hostile to evolutionism. To this charge we demur. We consider that the periodicity so far traced among the chemical elements should rank not against but in favour of their having been evolved on definite laws from some common pristine matter. In like manner, if any cyclical repetition should be traced in the animal and vegetable kingdoms, such results will by no means militate against evolution, even if it may tend to relegate " Natural Selection " to a less important position than that which it now occupies.

The second objection is of much graver character. Among the elements we have a certain important variable: the atomic weight. The task of the discoverers of the Periodic Law has been to exhibit the properties of the elements as periodic functions of such variable. But in plants and animals we know of nothing comparable to the atomic weights of the elements. Hence if we proceed at all in this inquiry it can only be by an inverse method : by inquiring what properties vary in any particular group, and recur varying in a corresponding manner in other groups. After tracing out such variations, it will then be necessary to inquire if there is anything of which these changes can be said to be periodic functions. The question is vastly complicated by the absence of the numerical element which plays so important a part in the lifeless world. Among the chemical elements we can exhibit certain important relations, such as specific gravities, malleabilities, ductilities, atomic volumes, manners and ranges of combining with oxygen, chlorine, or sulphur, &c., as reduced to numerical standards.

A very important reason in favour of making the attempt is involved in the principle of continuity. We see Evolution extending from suns to microbia. In an analogous manner, having seen Periodicity established in the inorganic elements and their natural compounds, the attempt to recognise this principle also in the living compounds of matter is at least not illegitimate.

It will at once strike all persons whose memory or whose reading extends into the former half of the present century, that an attempt,—perhaps rather a group of attempts,—was made to exhibit the organic world arranged on the principles of recurrence, or, in other words, of periodicity. This though undoubtedly made, and that by men of great learning, was trammelled by a variety of baseless assumptions, and still more by its open and avowed contempt for all considerations save those drawn from outwardly visible structure. Hence whatever evidence or guidance might have been reaped from physiological or from embryological considerations, and in great part from morphology also, was necessarily wanting.

Thus it may, we think, fairly be submitted that the principle of organic periodicity *per se* is not absolutely and for ever discredited by the admitted failures of MacLeay, Swainson, and their colleagues.

As a preliminary it will, at least, be useful to examine whether the chemical elements of which living bodies are composed hold any well-marked position in the Periodic classification?

The reply is in the affirmative. If we look at the table given, *e.g.*, in Mr. Muir's "Treatise on the Principles of Chemistry" (p. 225), we see that among the twelve series there given these elements are present in the 1st, 2nd, 3rd, 4th, 5th, and 7th only. In the 7th one only of these elements (iodine) is present, and in the 5th three: copper, zinc, and bromine. Now of these four elements, copper, though widely disseminated among plants, and met with in a few animals, occurs in small quantities only, and its especial function is in most cases still a matter of doubt. Zinc is much rarer, whilst iodine and bromine are chiefly confined to marine, or at least aquatic, forms of life. On the other hand, the only element which rank in the first series, hydrogen, is essential to all living beings; so are three at least of the second series: carbon, nitrogen, and oxygen; whilst fluorine, which also belongs to this series, is met with in the skeletons of all the higher animals. All the elements of the third series, to wit sodium, magnesium, aluminium (rarely), silicon, phosphorus, sulphur, and chlorine, enter into the structure of organisms. In the fourth series are the important elements of potassium and calcium, manganese, very widely present in plants, iron, and nickel, which, though it has not yet been demonstrated as present in any plant or animal, yet plays an important part in the pseudo-organisms produced by M. G. Fournier and by MM. Monnier and Vogt.

On the other hand, none of the elements forming the 6th, 8th, 9th, 10th, 11th, and 12th series of the classification enter into organic beings.

The first reply to any considerations founded upon this fact is that the "organic elements" above enumerated are merely a synonym for the commoner elements. Were baryta, for instance, as plentiful as lime, it also might be found in the tissues of plants and animals. At the same time it must be remembered that in the experiments of MM. Monnier and Vogt barium and strontium saccharates, unlike the corresponding calcium salt, did not lend themselves to the production of organic forms. It may be said that barium is highly poisonous. True, but strontium is not. The question further remains whether it is a mere matter of accident that the commoner elements, those holding the positions first mentioned, should exclusively enter into the structure of plants and animals? Perhaps those elements whose atomic weights are above that of iron (= 56) have taken a line of development which withdraws them from the play of those agencies which constitute life. If we look at the series of atomic weights we find that all the elements from carbon onwards to calcium, having respectively the atomic weights 12, 14, 16, 19, 23, 24, 27, 28, 31, 32, 35·5, 39, 40, are organisable, if we may use the term. Below this group we have only hydrogen (= 1), and above it merely manganese (55), iron (56), copper (63), zinc (65), bromine (80), and iodine (127). So that of the twenty organisable elements thirteen, or in round numbers two-thirds, have atomic weights situate between 12 and 40. This fact surely indicates that with higher atomic weights organisation becomes more difficult.

VII. THE INTER-RELATIONS OF THE SENSES.

IF we consider that the senses of man and of the vertebrate animals generally * are merely modifications of the common reaction to impressions from without, we may sometimes wonder that they are as isolated as we actually find them. It might be expected that any stimulus affecting one of the sense-organs would frequently have an influence upon some other also, each organ duly recording the impression made in its own language. We might even expect that in certain cases one sense-organ would vicariously perform the duties of another. Facts pointing in this direction, however, are rare, obscure, and not always well authenticated. We hear, indeed, of mesmeric subjects receiving light impressions, and even being able to distinguish objects by means of the skin of the forehead, the tips of the fingers, or of the nose, &c. But such phenomena, even if established, are of doubtful interpretation.

The relations between the senses of smell and taste are much more intimate than those between that of touch and any of the other four. It is even questioned whether either scent or taste can exist in anything more than a rudimentary form independently of the other. We know a lady who, as far as we can rightly interpret her very untechnical language, smells, or at least recognises, odours more with the root of the tongue and the palate than with the nose. She is very susceptible to all manner of scents, pleasant or offensive, and is always the first of her family to raise the alarm if there has been a slight escape of gas, if a candle has been blown out, if the chimney smokes, or if the cook is indulging in the preparation of acroleine. But to use her own expression, she "breathes" rather than smells the odour. Here, then, we have at least an approximation to vicarious action, —the posterior end of the tongue doing duty for the nose.

A curious fact is that the two allied senses in question, specially related as they are to that impulse which in its twin forms is the cause of nearly the sum total of animal activity, sometimes give each other the lie. Thus the nose tells us that the durrian fruit is loathsome and repugnant as

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* Our knowledge of the senses of the invertebrate animals is very rudimentary. We know not even their number, much less to what extent they have been differentiated from each other.

carrion,—warns us, in fact, by no means to eat it. But the tongue, if once we venture on the experiment, pronounces it delicious. On the contrary, the nose detects a faint but attractive fruit aroma in the infusion of even chamomile, or even sometimes in that of gentian, liquids which the tongue rejects with abhorrence.*

The two remaining senses seem at first glance essentially distinct and having no relations. True, both take cognizance of vibrations, the one relatively slow as the other very rapid. But, as a rule, they neither supplement each other, nor does an impression made upon the organ of the one call forth any reaction in the other. Exceptional cases, however, occur, and to these we wish to direct attention. Certain persons, namely, on hearing a given sound, or class of sounds, assert that they perceive at the same time or are conscious of certain colour-sensations corresponding to and varying with the sound heard.

Two observations must here be made. The only evidence we have of the phenomenon in question is the assertion of the person under observation. If he merely fancies that he experiences colour-sensations in connection with sounds,—if the phenomenon is due to some early association, or if he is simply amusing himself at our expense, we have no means for his detection.

The second preliminary point is that we have no instance on record of a converse association. No one, as far as we have been able to trace, on seeing a colour has heard, or fancied he heard or experienced any corresponding sound-sensation. Sound, it would seem, to some persons at least, suggests colour, but colour does not suggest sound.

The first notice of this subject appeared as far back as 1873, when Dr. Nüssbaumer contributed to a Vienna medical paper an essay on "The Subjective Sensations of Colours Produced by the Objective Impression of the Hearing." The subject has since been studied by Bleuler and Lehmann in Germany, by Pedrono and De Roches in France, and by Velardi, Berti, Bareggi, Quaglimo, Lussana, Grazzi, and Ughetti in Italy. The evidence collected by these observers, however, can scarcely be said to agree beyond the fundamental point that sounds heard suggest or call up the impression of colour.

M. Pedrono's subject perceives a different coloured sensation for each musical note; but he is unable to define the colours distinctly. Two neighbouring notes seem to him almost identical. The highest notes are, for him, accompanied with brilliant colours, and the low notes with sombre colours.—(See "Annales d'Oculistique," Nov. and Dec., 1882.)

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* The toleration of and even liking for bitters is a symptom of decaying vigour, individual or racial.

In a perfect chord the three notes, if they vibrate absolutely together, produce the impression of one and the same colour, resulting from the three harmonious notes. The chord of *fa* major produces a yellow colour and that of *la* minor a violet. In a discord some of the notes seem to detach themselves with their especial colour to a small distance from the other colours.

The key does not seem to have any action on the production of the chromatic sensation. We find no relation between the colours called up by major keys and by the corresponding minor keys. If we transpose a piece of music from one key to another, the tint is more brilliant if we pass to higher tones, but more sombre in the reverse case.

One and the same piece of music played upon different instruments presents different colours. Thus the Breton air, *Au Hollaika*, played on a tenor saxophone or a harmonium is yellow; it is red on a clarionet and blue on a piano.

Every noise (as distinguished from musical sounds) produces a chromatic perception, but the colours are sombre, generally grey. The more intense the sound, the more the colour sensation is accentuated. A very dull sound, like, for instance, that of a cannon at a great distance, provokes merely a luminous sensation without colour. When the noise becomes hissing, and more and more acute, the corresponding sensation turns to a red, passing through yellow, grey, and blue.

The intensity of a sound makes the colour more definite. When the sound is feeble, the colour seems to experience oscillatory movements like those of the air. When the sound becomes clear and distinct, the colour also becomes uniform and well characterised.

Words pronounced in conversation call up a colour-sensation which depends solely on the timbre of the voice. The intensity of this sensation is not due to the consonants, which, when pronounced separately, excite a chromatic sensation scarcely appreciable, but to the vowels. The vessels *i* and *e* (pronounced, of course, as in Italian, German, &c.), are accompanied by the most brilliant colours; *ou* (*oo*) produces the darkest colour, *a* and *o* intermediate colours. The diphthongs are accompanied with a chromatic impression occupying an intermediate position between the impressions produced by the component vowels.

Voices appear variously coloured, according to their timbre; the subject observed a recognised yellow, red, green, and blue voices. Blue voices are the most common and green the rarest.

The observations by Signor Ughetti, as published in "La *Natura*" of 1884, are more precise. His observations have been made upon a physician, Dr. *Z.*, a man of about 40 years of age. This gentleman, when a student, noticed, to his no small surprise, that for him *a* was black, *e* yellow, *i* red, *o* white, and *u* (in Italian, *oo* in English) coffee coloured. Since that time his chromatic impressions have not varied, and he declares that it is impossible for him to change them by any act of the imagination. The simple utterance of the vowel *e* (Italian), calls up in his brain the same notion as the word "yellow."

In conversation Dr. *Z.*, unlike M. Pedrono's subject, cannot distinguish the colour belonging to each vowel on account of the rapid succession of the words. It is different, however, when the same vowel occurs repeatedly in any word. Thus, for him *ballata* is black, *horoscope* white, *neve* yellow, *liri* red, *mai* black and red. His chromo-acoustic gamut, if we may use the expression, comprises white, black, red, orange, and yellow, but neither green nor blue.

Dr. *Z.*, like Pedrono's subject, ascribes a specific colour to the sound of each instrument. To him the sound of the flute is always red, ranging from a dark red in the lower notes to a light red in the upper. Yellow predominates in the clarionet, the guitar and the trumpet are gold-yellow, and the piano white!

One of the sounds which produce upon him the best defined effects is the whistle of a steamer on setting out. Its sharp metallic clangour varies from a dark red to a light red, according to its degree of acuteness, so that he is in the habit of saying that the whistle of one ship is *redder* than that of another. Locomotive whistles which have more varied modulations pass from red to white.

Berti's subject has different sensations from those of Dr. *Z.* With him *u* (*oo*) is not coffee-coloured but dark blue, and *e* grey instead of orange.

Among 596 persons questioned by Bleuller and Lehmann, in Germany 75 answered invariably that *a* was black, *o* white, and *i* red.

Lussance reports that two brothers, students at Padua, saw deep voices as black and high ones as red.

A French journal, " L'Intermediare des Chercheurs et des Curieux" for June 25th and September 25th of last year, gives an instance of two ladies who ascribed colours to sounds, but differed in almost every particular.

On looking over these details we find complication and contradiction. If a physicist had been asked as to a probable connection between sounds and colours he would probably have suggested that each note of the gamut would correspond to one of the spectral colours, whilst noise, as distinct from sound, would suggest browns, olives, blacks, and other impure colours. But of such a regularity we find nothing. The chromatic sensations called up by any sound seem to be influenced—

a. By the speciality of the instrument producing such sound.
b. By its pitch, as high or low.
c. By its place in the gamut, according, at least, to M. Pedrono's subject.

We have thus at least three distinct factors, and even if all the subjects agreed in their indications we should have no little difficulty in reducing the phenomena under any regular law.

The most important question is whether we have to do here with a capricious idiosyncracy which may take different forms in different persons, or with a reversion to an ancestral stage in which the senses of hearing and sight were less sharply differentiated than at present.

The persons who experience these chromatic impressions should be more exhaustively examined. Above all inquiries are needed on the possible occurrence of the converse case, —the suggestion of sounds by colours, as well on the possible suggestion of sounds and colours by odours and flavours, or reciprocally.

VIII. THE ORIGIN AND PRODUCTION OF DOUBLE MONSTROSITIES.

THE problem as to the origin of such monstrosities has been formerly attacked in a somewhat *a priori* manner by the aid of two antagonistic theories of fission and of coalescence. Recent advances in the study of normal development, as well as experiments on the artificial production of monstrosities by pressure, and the unsymmetrical application of heat, have shown that the question was formerly inaccurately put. Dr. L. Gerlach has recently thrown a new light on this subject in a treatise on the origin of twin monstrosities among the higher vertebrates. He shows that such a phenomenon as the coalescence of two mature ova does not occur, and that the malformation extends back to the earliest time of the development of the embryo. Hence the question to be put is: do we first perceive, in double monstrosities, the initial stages of a single individual or of two?

The existence of two *areæ pellucidæ* and of two separate vitelline membranes upon a single yolk may be distinctly observed in birds, but not in mammals. In these cases there may be, if not a coalescence of two preformed embryos, at any rate a confluence during their formation. Where there is only one *area pellucida*, there may be developed within it one primary stripe or two; if two, they may either be developed distinctly from each other, thus producing twins, or they may interfere with each other, and thus eventuate in double monstrosities. Even a single primitive stripe may become bifurcated, and thus produce a double monstrosity, in which the anterior extremity is doubled, but the posterior single.

The origin of such anteriorly doubled monstrosities was examined by the author in two decided and three approximate cases. The surface of a fresh hen's egg was coated over with varnish, except a V-shaped part, at an equal distance from the blunt and the pointed end at right angles to a line connecting both. The access of air was thus limited to this spot. The egg was let remain in such a position that the free spot remained turned upwards. Thus probably the incipient primary stripe lies in the longitudinal direction of the V. The author was led to this process by the consideration that all development depends on the growth and multiplication of cells, for which process the access of oxygen is absolutely necessary. Therefore, by limiting the admission of oxygen to certain lines, the development in its first stages could be forced in a certain direction.

Of 60 eggs thus treated, two, after remaining from three to six days in the incubator, exhibited a decided anterior duplication of the embryo, three a striking expansion of the anterior end with an indication of division; two, an expansion without any such indication, and some various other anomalies.

ANALYSES OF BOOKS.

Special Creation and Evolution. An Exposition of the Opening Chapters of Mr. Herbert Spencer's "Principles of Biology," Part III. By CONSTANCE C. W. NADEN. Birmingham: Cornish Bros.

THE substance of this treatise was read in January of the present year before the "Sociological Section" of the Birmingham Natural History and Microscopical Society. All thoughtful readers must agree that it presents a masterly analysis of the teachings of Mr. Herbert Spencer concerning the great question of Evolution. It may be well to point out the fundamental difference in Mr. Spencer's point of view from that of Buffon, Lamarck, Oken, and the two Darwins. This difference is none the less capital, although the conclusion reached is substantially the same.

Charles Darwin—we use his name as a general expression for an entire school, including his forerunners, his coadjutors, and his followers—attacks the problem *a posteriori*, as a naturalist, from a minute survey of the phenomena of animal and vegetal life. These phenomena he finds inconsistent with the hypothesis of special—or, as it is otherwise called, mechanical or contract-creation—and to be explained only on the hypothesis of gradual development from some pristine form or forms of life.

Mr. Spencer, on the other hand, as a philosopher, takes up the question from the *a priori* side. He shows that the hypothesis of special creation involves difficulties, intellectual and even moral, which amount even to unthinkableness, but which conversely all become powerful arguments in favour of Evolution.

It is utterly idle, or rather much worse than idle, to inquire which of these two ways of approaching the subject is the more effectual, and consequently whether Darwin or Spencer has had the greater share in the great mental revolution of the nineteenth century. The two methods mutually complement and confirm each other. Darwin and Spencer may be likened to two allied generals who arrive simultaneously by different routes, and fall upon the enemy the one in front and the other in the rear. This illustration, however, in one respect falls short of the reality of the case. We have no reason to believe that Spencer and Darwin were working in concert, or that either was at all influenced by the results of the other.

Mr. Spencer's objections to the hypothesis of Special Creation, as here summarised, are: the improbability of that idea being true as a consequence of the very fact of its earliness. We know that the traditional conceptions of pristine man concerning earth, air, and sea, and all that is therein, were false—absurdly false. There is, therefore, a strong antecedent probability that the hypothesis of Special Creation, formulated at the same time, must be of the same character.

Mr. Spencer's second objection is a development of the first. "The Special Creation hypothesis belongs not only to an order of mistaken and decaying beliefs, but to a special genus of that order." It is one of the cases where primitive man interprets nature in terms of his own consciousness. For him "there is no law of nature to be fulfilled or violated; no physical sequence to be maintained or set aside; and consequently there can be no such thing as miracle, or as what we profanely term '*Divine interference*.'" The author rightly pronounces it strange and inconsistent that "the dogma of Special Creation is retained by men who would smile at the similar dogma of the dependence of sunrise on a direct act of volition."

The third objection is the utter absence of the slightest approach to evidence in favour of Special Creation. No one has seen an animal or a plant originating in any way save by propagation of its like. Some persons affect to disbelieve evolution because they have never seen an ape develop into a man, or a man revert to an ape,—changes, by the way, which Evolution in nowise supposes or requires. But how much the more, then, should they reject Special Creation!

The fourth difficulty, as Miss Naden well remarks, renders all other arguments superfluous. All *savants*, all thinkers must agree that a working hypothesis must be thinkable and intelligible. But the Special Creation hypothesis is not thinkable. It introduces a mode of action "which does not resemble any mode of action with which we are acquainted; which is not a *vera causa*." Are we to suppose animals condensing out of the air or the water, or sprouting up out of the earth? We may here note how much of the so-called Scriptural objection to the Evolutionist hypothesis is due not to the Mosaic record, but to the glosses of the artists and the poets. A heavy responsibility in this respect rests upon John Milton. We can scarcely help thinking that our modern conceptions of the origin of the animal world would have been clearer and more rational if the "Paradise Lost" had never been written.

Mr. Spencer's fifth argument is from analogy. Taking up Paley's illustration of the watch picked up on a heath, from which the finder is supposed to infer the existence of a watchmaker, he replies: yes, "but if we found a bird we should infer that it had been hatched; if we picked up a baby, that it had been born. . . Now an organic species evidently presents greater affinity with an organic individual than with an artificia product; consequently we are justified in inferring *a priori* that the species, like the individual, has been born rather than made."

It may here be suggested that the supposed finder of the watch would not infer the existence of the watchmaker unless he had previous knowledge of the existence of watchmakers, or of makers, at least, of some other machines. It is recorded that in the last century a Highland lassie, going to service in the house of a Lowland laird, saw for the first time in her life a clock. On the second or third day, she exclaimed: "Well, since I have been here nobody has given that creature anything to eat." This poor girl, and even Mrs. Beecher-Stowe's Topsy, in "Uncle Tom's Cabin," who "'spects she'd grow'd," were, perhaps, more capable of biological conceptions and less mechanical than the man who is supposed to find the watch.

It is commonly urged by anti-evolutionists that during historical ages no essential change has been observed in any animal or vegetable species. Mr. Spencer replies that, in like manner, "an intelligent ephemeron, perceiving no apparent change of structure in human beings during the few hours over which his observation extended, would probably infer that each man and woman had been separately created, and had, from the outset, possessed all the characters then visible."

This supposition is illustrated by a very curious fact, appositely quoted from Mr. Powell's "Report to the Smithsonian Institution," that some of the Aboriginal races of North America are exercised by the question: "Do the trees grow or were they separately created? That the grass grows they admit, but their orthodox philosophers stoutly assert that the forest pines and the great Sequoias were created as they are."* There are two considerations which anti-evolutionists would do well to bear in mind, although they belong to the *a posteriori* rather than to the *a priori* argument:—Only a very few animal or vegetable species have been observed with sufficient closeness to detect any incipient changes, and even in the most favourable cases this observation does not extend over a longer time than 5000 years; secondly, if so-called species have not changed within the historical period neither have the races or breeds of certain species. If the supposed permanence proves in the one case individual distinct creation, it must in the other also. The anti-evolutionist contention to which we refer was we believe first raised by the French expedition to Egypt under the first Napoleon, and it is generally spoken of as the "Egyptian" argument. It hovers to this day, before the eyes of the French Academy of Sciences,—a survival of Egyptian darkness.

Miss Naden may be congratulated on the manner in which she has presented Mr. Spencer's argument to her hearers.

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* It does not appear whether this quotation is made by Mr. Spencer or by Miss Naden.

The Sun: a Familiar Description of his Phenomena. By the Rev. W. Webb, M.A., F.R.A.S. London: Longmans, Green, and Co.

The author of this little treatise claims for Astronomy the first and highest position of all the sciences—a point on which there is room for difference of opinion. He divides Astronomy into a theoretical branch, an observational, and a descriptive, the last of which alone admits of being popularised. He confines himself, further, for the present, to a description of one of the heavenly bodies, that which in every way most concerns man—the Sun. He raises even the somewhat *naive* question, "What should we do without him?" To this query the answer is easy: we should either have never existed at all, or should have been creatures of which we can frame not the remotest conception.

The author takes up the questions as to the nature, the material, the size, and distance of the Sun. In explanation of the latter point he gives a very clear account of the manner in which transits of Venus are employed for the determination of our distance from the Sun. In speaking of the Sun's magnitude he refers to its apparent increase when near the horizon, and gives the doubtful explanation of this illusion that both it and the Moon look very large in that position, "because we think that they ought to appear much smaller at a supposed greater distance."

The Sun-spots next engage the author's attention. After describing their appearance and their periodicity, he concludes that they are probably openings in the photosphere through which we look down upon something at a lower level.

As concerns the influence, real or supposed, of the Sun-spots upon a number of terrestrial phenomena, Mr. Webb observes a possibly judicious silence. The temperature of the Sun is also left, in view of the discrepant results of observers and calculators, an open question.

We come next to an account of the recent spectroscopic researches on the Sun's constitution, of the chromosphere, the zodiacal light, and of the Sun's relation to electrical—and especially to magnetic—phenomena.

It will be seen throughout that the author deals merely with what may be regarded as fairly established, avoiding the regions of doubtful speculation. Within these boundaries he has given to the public an accurate, clear, and readable guide to one of the most important departments of Astronomy.

An Analysis of the Principles of Economics. Part I. By PATRICK GEDDES. London and Edinburgh: Williams and Norgate.

THE substance of this treatise is a memoir read before the Royal Society of Edinburgh, on March 17th, April 17th, and July 7th, last year. The contents, as will be anticipated by all who are acquainted with the author's antecedents, differ most favourably from the productions of the normal British economists. Of this class of men it may truly be said that, with the exception of the lamented Prof. Jevons, they are chiefly distinguished by their ignorance of, and often contempt for, every science, save their own body of doctrine.

The question must arise, In what light must political economy be considered? We should be apt to regard it as a fragmentary portion of Sociology, just as would be, *e.g.*, the physiology of respiration or of digestion if studied apart from, and in neglect of, general physiology. Mr. Geddes, however, advances a different view, for which much may be said, *viz.*, that it is a "crude science, standing to Sociology much as the Psychology of the last century to that now in process of evolution." In its ultimate results this way of regarding economics differs little from our own, since both alike refuse to it the rank of a definitive body of doctrine.

Mr. Geddes warns his readers against two errors, formidable in all sciences which bear directly upon man, and here perhaps most formidable of all. One of these aberrations is that "theoretic conceptions are subtly, almost inextricably, interwoven with practical considerations."

The first aim of the work before us is the disentangling of this confusion, or, in the author's own words, "to distinguish doctrine from practice, to separate principle from precept, and to construct Science apart from Art."

The second error—still more difficult of elimination—is the introduction of extra-scientific conceptions and methods.

The "notorious discord and sterility of modern economics"* has now to be explained. For this unsatisfactory state of things the author propounds two valid reasons:—The applications of the various sciences to the elaboration of this discipline has not been systematic or co-ordinated, and, when and where attempted, such applications have been imperfect or faulty. As instances, it can scarcely be assumed that "material wealth," "intrinsic value," &c., can be rightly discussed in neglect of the fundamental principles of modern physics. Yet "in the outset of almost every economic treatise" this vain attempt is made.

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* INGRAM, On Present Position of Political Economy.

The like is the case with the ideas of "competition" and "co-operation." These are manifestly biological conceptions; yet our normal professor of economics still treats these points without reference to the "general conceptions of struggle for existence, functional differentiation and change, polymorphism, and the like, of which they are really special cases." This, surely, is undeniable by anyone who knows what the author is really discussing.

But we have to go with him a step further. The normal economists interweave in their systems obsolete theories on man's mental and moral nature, quite out of harmony with any school of Psychology now existing. In like manner they indulge in views on the origin and structure of society which savour rather of the "*Contrat Social*" than of any scientific results on these subjects.

Mr. Geddes then argues that the student of economics should prepare himself for his task by a preliminary study of the sciences—Mathematics, Physics, Biology, Psychology. He is not called upon to become a specialist or a discoverer in any of these sciences, but merely to acquire a rudimentary, but clear and accurate, insight into their principles and their methods.

In the application of these preliminary sciences to Economics we find mention of two errors to which the author gives the names of "Materialism" and "Transcendentalism," using these terms in somewhat novel sense. Under "Materialism" he ranks the intrusion of each science upon the domain of its ascending successors, whilst "Transcendentalism" is the converse attempt to make any one science do duty for those which underlie it. Terms are certainly wanting for the errors which Mr. Geddes points out, but we fear that the public will confound the proposed connotations of these words with those sanctioned by convention.

The author then proceeds to expound in succession the physical, the biological, and the psychological principles of Economics, giving as an appendix to each a practical application. As an instance of the analysis to which he submits the common platitudes of economic "science," we may instance the manner in which he discusses the oft-quoted saying of Bastiat, that "a value does not reside in the commodities themselves, and is no more to be found in a loaf of bread than in a diamond, the water, or the air," but merely, according to him, in its purchasing power. Mr. Geddes, on the contrary, shows that loaf and diamond have, (1) a mathematical value, *i.e.*, they are exchangeable in a certain ratio; (2) a physical value, *i.e.*, they contain as combustibles a certain number of units of potential energy; (3) a physiological value, *i.e*, the loaf is capable of maintaining an average adult for a certain definite time, whilst the diamond possesses a definite power of sensory stimulus; (4) a psychological value, *i.e.*, a subjective aspect relating to human wants or desires; and (5) a sociological value, which they acquire as property.

The author sums up this first part of his work by showing that the physical analysis leads to the exposition of the mechanical aspect of society, to the re-organisation of the theory of production and consumption, culminating in the generalisation of the synergy of the race. The biological discussion sketches "the higher aspects of the same phenomena, defines production, and discusses the relation of organism to environment and function, the definition of production being obtained in terms of maintenance and evolution." The psychological analysis shows that certain subjects hitherto ignored by economists are yet necessary and integral parts of the subject.

We shall look forward with eagerness to the completion of this work, which will, we believe, relieve political economy from the double charge of dismalness and unfruitfulness. Its regeneration, as it will be seen, depends in no small measure upon the author's judicious application of the principles of Evolution which are fast transforming all the higher sciences.

Jelly-Fish, Star-Fish, and Sea-Urchins; being a Research on Primitive Nervous Systems. By G. J. ROMANES, F.R.S. London: Kegan Paul, Trench, and Co.

THIS work is substantially an investigation into the nervous system in its earliest and simplest forms, manifested in the species above mentioned. The author's original intention was to furnish a monograph of the morphology and physiology of the *Medusæ* and *Echinodermata*, but finding such a task incompatible with the limits of a volume of the "International Scientific Series" he has given merely an account of his own researches in this direction. This account will be found both interesting and important.

Incidentally, in his introduction Mr. Romanes deals with two of the cavils now urged againt the organic sciences by æsthetics and sentimentalists. We are aware that against these gainsayers some eminent authorities recommend and practise a policy of "masterly inactivity." But here, as elsewhere, that policy has been found fraught with deadly peril. To those who hold that the analysis of Science withdraws from the face of creations a veil of enchantment he replies that "our human nature is not so much out of joint that the rational desire to know is incompatible with the emotional impulse to admire." From his own experience he can testify that his "admiration of the extreme beauty of these animals has been greatly enhanced by the continuous and close observation which his experiments required."

A few words are then written in justification of science as against those worst abortions of a neuropathic age known as Bestiarians, Zoophilists, Humanasters, &c. These worthies hold, for some reason incomprehensible to all but themselves, that whilst the infliction of pain and death upon animals for other purposes is justifiable, yet if in pursuit of knowledge it is a "horrible sin." To the stale Old Bailey quibble that "two blacks do not make a white" we reply that in the laboratory they occasionally do, and that even when they do not it has long been held ridiculous for the kettle to stand forth and denounce the pot.

In his first chapter the author gives a brief description of those features in the anatomy of the *Medusæ* which are necessary for an understanding of his researches. He calls especial attention to these animals as displaying in the cover of their manubrium and in the lining of the umbrella true contractile tissue. We have, in other words, here the first appearance of muscular fibre. The same thing may, according to the author's investigations, be said of nerve-tissue, though so eminent an authority as Professor Huxley declared in his "Classification of Animals" that "no nervous system has yet been discovered in any of these animals." Mr. Romanes insists on the characteristic necessary for distinguishing muscle from nerve. A stimulus, namely, applied to a nerveless muscle can only pass through the muscle by occasioning a visible wave of contraction. A nerve, on the contrary, conveys any stimulus without any visible movement or change of shape.

In the next chapter we find an account of the author's fundamental experiments. The results he himself summarises as follows:—In the naked-eyed *Medusæ* the removal of the extreme periphery of the animal causes instantaneous, complete, and permanent paralysis of the locomotor system. In the genus *Sarsia*, indeed, the principal locomotor centres are the marginal bodies, though every minutest portion of the spaces of the margin between the tentacles has the property of setting up locomotive impulses.

Among the covered-eyed *Medusæ* the margin is, indeed, the principal, but not, as in the former group, the *exclusive* seat of spontaneity. Hence, though the removal of the margin destroys the spontaneity of the creature for a time, yet the paralysis thus produced is seldom permanent.

Even after the removal of their locomotor centres all the *Medusæ* respond to mechanical, chemical, luminous, thermal, and electric stimulation. The sense of sight is demonstrably present, *e. g.*, in *Sarsia*. The marginal bodies subserve the visual function, but the author prudently declines to assert that they are so fully specialised as sight organs as to be incapable of ministering simultaneously to any other sense. The ultra-red heat-rays were not found to have any effect upon these visual organs, no more than the ultra-violet. All the luminous rays of the spectrum affected these animals when employed separately, and no difference was recognised between the action of direct sunlight, diffused daylight, and light polarised by reflection.

The study of electrical stimulation leads the author to some interesting conclusions. We refer here to the "summation of stimuli,"—a most important physiological principle. If any single stimulus, natural or artificial, is given to the excitable tissues of a jelly-fish, "a short period,—the so-called period of latency,—elapses, and the animal gives a single weak contraction. If as soon as the tissue has relaxed the stimulation is repeated, the period of latency becomes shorter and the contraction stronger. . . . And so on up to nine or ten times, when the period of latency is reduced to the minimum and the force of the contraction is raised to its maximum." Thus successive excitations arouse the tissue to increased activity, and produce in it "a state of greater expectancy." Similar effects have been traced in the case of excitable plants, in the heart of the frog, and in the reflex action of the spinal cord. The author gives instances of this summation of stimuli in the organisation of the higher animals and in our own,—and others will at once occur to the reader. He thinks that even in the domain of psychology the action of this principle may be traced, whether in "the rhythmical waves of emotion characteristic of grief," or in the opposite case of the ludicrous. Thus we see from the excitable tissues of a plant up to the most complex of our psychological processes there is distinct social continuity.

The experiments described in the next chapter on the "Section of Covered-eyed Medusæ" lead to a discussion of Mr. Herbert Spencer's theory on the genesis of nerve-tissue. This theory is substantially that "incipient conductile tissues or rudimentary nerve-fibres are differentiated from the surrounding contractile tissues or homogeneous protoplasm by a process of integration which is due simply to use; so that just as water continually widens and deepens the channel through which it flows, so molecular or nervous waves of stimulation, by always flowing through the same tissue-tracts, tend ever more and more to excavate for themselves functionally differentiated lines of passage."

Mr. Romanes, in view of the proof that the nerve-plexus in question is composed of fully differentiated nerves, thinks that this hypothesis still holds as being the only one available, but that it "need not now be applied to the genesis of nerve-tissue out of comparatively undifferentiated contractile tissue, but rather to the increasing the functional activity of already well-differentiated nerve-tissue."

Passing over, as compelled by the limited space at our disposal, the chapters on the section of the naked-eyed *Medusæ*, on co-ordination, natural rhythm, and artificial rhythm, we come to an investigation on the action of poisons. Here we find a striking resemblance between the action of poisons on the *Medusæ* and in the higher animals.

Fresh water appears to have a deadly influence upon the *Medusæ*,—not so rapidly, however, as Professor Agassiz asserts. Nor is this influence due, as the same authority holds, to the mere difference of specific gravity, since fresh water is still fatal to these animals if its specific gravity is raised to that of sea-water by the addition of neutral salts or of sugar.

We must here, however, conclude. The interest of Mr. Romanes' book lies not so much in the advancement of our knowledge of the *Medusæ*, considered by themselves, as in the light thrown on the origin and development of the nervous system in general. As such it is for the naturalist most instructive reading, to whom it will not fail to suggest further trains of research.

An Elementary Treatise on Dynamics, containing Applications to Thermodynamics, with numerous Examples. By B. WILLIAMSON, M.A., F.R.S., and F. A. TARLETON, LL.D. London: Longmans, Green, and Co.

IN this very thorough-going treatise the authors discuss in succession velocity, acceleration, the laws of motion, rectilinear and parabolic, friction, momentum, action and reaction, impact and collision, circular motion, including harmonic motion, centrifugal force and motion in a vertical circle, work and energy, central forces, constrained motion and resisting medium, motion of a rigid body parallel to a fixed plane, motion of a rigid body in general, small oscillations, dynamical principles and application of the theory of energy to thermodynamics. To readers who are not mathematicians this work will prove simply unintelligible, whilst the student acquainted with the differential calculus will find it an excellent, and we think a sufficient, guide in the study of dynamics. Although there are examples in abundance we are glad not to find a list of questions set, &c., at such and such an examination.

Supplement to a Treatise on Gold and Silver. To show a Chief Cause of Present Depression in Trade and Shrinkage in Value of all Produce and Property. By GEORGE O'BRIEN. Dedicated to the Right Hon. W. Ewart Gladstone, M.P. London : "Mining Journal" Office.

THIS pamphlet is an important supplement to a treatise by the same author which we had the pleasure of noticing in our issue for February. There prevails an opinion among economists that the recent fall in the value of silver as compared with that of gold is due to an excess in the supply of the former. Nothing can be more wide of the truth. The "plethora of silver," so much complained of in certain quarters, is chiefly due to its demonetisation in Germany, and to a greater or less extent in other countries. Hence a considerable quantity of silver has been thrown upon the market, with the natural result of reducing its value. Whether this demonetisation was undertaken in some quarters in the hope of damaging British interests, is a question which we must leave to be discussed by our political contemporaries.

Our task is rather to follow Mr. O'Brien's brief and conclusive demonstration that the yield of silver, like that of gold, is by no means unlimited, and that most of the known sources of supply are approaching exhaustion.

The author first calls attention to the curious fact that silver mainly belongs to the American continent, and there only to the great mountain-chain known in its Southern portion as the Andes. In Europe, Asia, Africa, and Australia it is not now, and apparently has not for ages been, found in any quantity likely to affect the market. What were the sources which in the days of Solomon made this metal "as stones" at Jerusalem, and "of no account," we cannot say. Certain it is the silver mines of the eastern hemisphere had during the Christian era been very sparingly productive. Hence the supplies that flowed in from Mexico and Peru, during the reign of the Emperor Charles V., gave an impulse to commerce similar to that which in our time followed upon the opening up of the Californian and Australian gold deposits.

Mr. O'Brien opens his review of the silver-yielding countries of America with Chili. This State, since 1835, has yielded silver to the value of more than 60 millions sterling, chiefly from the three districts of Arqueros, Chanarcillo, and Tres Puntas. All these three are substantially abandoned from exhaustion. Caracoles, on the frontiers of Bolivia, is not in a flourishing condition. The Peruvian mines of Potosi and Cerro del Pasco are nearly exhausted.

In Mexico and in certain of the United States, such as Nevada, Montana, Colorado, and Utah, much silver occurs. But in Mexico the most productive deposits have during the three centuries of Spanish rule been discovered and ransacked.

It is sometimes contended that the system of extracting the precious metal from its ores, as followed by the Spanish-American population, is very imperfect. This is a mistake. Humboldt, himself a pupil of the great Freiberg Mining School, came, after a very close investigation, to a different conclusion. European capitalists who have thought that, by the introduction of Cornish miners and Saxon smelters, they could open up a new epoch of prosperity, have repeatedly had to smart for their rashness. One especially unpleasant fact remains: if the wages and other outlay in each mining district in South America are compared with the quantity of fine silver realised, a loss of about 50 per cent is perceptible! Thus the Spanish-American republics are being impoverished by this ruinous industry, and hence they perforce must cease to be importers of British manufactures. In the United States wages are about three times higher than in Mexico and Peru, and if the process of silver mining proves to be a losing game we need not flatter ourselves that the shrewd Americans will carry it on long.

All things considered, the author finds that the world's annual yield of silver cannot be rated as higher than ten millions sterling annually, with no definite prospect of its increase. Hence, he argues that the re-monetisation of this metal is not so much expedient as absolutely necessary in the present depressed state of trade. We wish our Government would venture on the experiment.

Bulletin of the California Academy of Sciences. Nos. 2 and 3, January and February, 1885. San Francisco: G. Spaulding and Co.

The former of these issues is devoted to a crystallographic study of Colemanite, a new borate of lime, discovered, it appears, by Mr. R. Neuschwander, and now under examination by the author, Mr. A. Wendell Jackson. We may be permitted to ask whether the term morphology is not here used in a somewhat unusual manner, as it is ordinarily taken to signify the structure of organised beings. The mineral in question very closely approximates to datholite, but is yet a distinct species.

Mr. J. T. Evans communicates a chemical examination of colemanite, pointing out its relations to pandermite and priceite, and he raises the question whether pandermite may not be an altered or derived form of colemanite?

In the second issue, Dr. H. H. Behr gives an account of three new Lepidoptera, *Euperia sambuci*, *Atethmia canescens* (two varieties), and *Anarta mimuli*. He unfortunately commits the indiscretion of giving his descriptions in Latin. Why this "survival" should be more common in entomology than in other sciences it might be hard to show.

The same author communicates a useful "biological synopsis" of the Californian Lepidoptera. He gives in parallel columns the name of the insect, its food-plant, its degree of frequency, and, if destructive, whether it is an endemic or epidemic pest; in the fourth, the season of appearance of the mature insect. If there are more broods than one, this is expressed by a 2 or a ∞. If only one brood, it is called vernal if it appears before the flowering of *Æsculus Californica*, æstival if during that time, and autumnal if later. It will somewhat surprise the British entomologist to find *Deilephila lineata* not merely common, but two-brooded, and sometimes an epidemic pest.

Mr. E. Lee Greene contributes "Studies in the Botany of California and Parts adjacent." This paper includes a very careful account of the genus *Eschscholzia*, one of the most characteristic forms of the Pacific coast.

Mrs. Mary K. Curran furnishes a list of the plants described in California, by Dr. A. Kellogg, Dr. E. H. Behr, and Mr. H. N. Bolander.

Mr. H. W. Harkness describes the fungi of the Pacific coast, and gives some notes on nomenclature.

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

EGO-COSMISM; OR THE IDENTITY OF SENSE AND ITS OBJECTS.

"So like the soul [life] of me. What if it were me?"
EMERSON, *On Nature.*

In "Knowledge" of February 27th is a letter, "Mind and Body," which, after balancing the probabilities *pro* and *con* the venerable doctrine of the immortality of the soul, anxiously asks:—"But who will solve this problem, and for ever set the mind at rest?" The query recals the self-torturing poet and sophist Shelley's piteous appeal on the same *quæstio vexata*:—

"One step to the death-bed,
And one to the bier;
And one to the charnel,
And one—Oh! where?"

None of which usual sequels of death fell to his lot, having been drowned at sea, and his body cremated on its shore. But in reality the query now-a-days is a very simple one—an enigma requiring a *Davus* only, not an *Œdipus*, for its solution. For I confidently submit to the judgment of your readers that it really was settled, once for all, nearly two centuries ago, when Newton, by his discovery of universal gravitation, proved the automatism or self-activity of Matter. By this ideal he exhibited the macrocosm as a mechanism—an organism or inorganism matters nothing, since Chemistry has removed the distinction—endowed with self-centred motor force sufficient to perform all its own operations, and therefore neither requiring or admitting of any soul, *anima*, or spirit to perform functions already provided for by its own *vis insita* or *propria*. This self-evident fact, though ignored by Newton himself,—who from his other writings must be regarded as a Pre-Newtonian College Don, saturated with all the Baconian *idola*,—was at once recognised by the younger generation of formal physicists, and even by far-seeing elder ones, like Leibnitz, free from academic *myopia*. That encyclopedic and cosmopolitan thinker, indeed, expressly complained to the Princess of Wales, afterwards Queen Caroline, that Newton, by his "revival of occult causes," had destroyed the very essence of Natural Religion. It was long considered abroad that such was the case; it was the all but universal belief, even when Voltaire and Madame du Châtelet popularised the Newtonian Physics, well on in the 18th century, at which epoch—long after Newton's death in extreme old age—only a handful of continental geometers were converts to the much-decried English Materialism. The chief objections were on the score of its irreligion, on its abrogation of spiritual *influx* or *impulse*,—a point Halley at once recognised, thereby earning the reputation of Atheism, which eventually alienated him from the founder of that sublime system he himself had done so much to establish. Since the publication of the "Principia," then, in 1687,—one year before the English Revolution,—it seems perfectly certain that Materialistic Monism, not Spiritualistic Dualism, has been the watchword of the Universe.* The idea, therefore, of a *caput mortuum*, inert Matter, "*animated*" by Spirit, which to me seems, moreover, a quite incoherent and inconceivable hypothesis, has not only no *locus standi* whatever, but is relegated to the limbo of other exploded provisional *pseudo*-sciences, as Alchemy, Astrology, Phrenology, &c., by all the canons of Physics and Logic. Mind is clearly seen to be only the dynamical condition of the cerebral vesiculo-neurine, as Motion is of Muscle. It is just as absurd and untenable to teach, or hold, the union of two separate entities, Mind and Matter, as it would be in the case of Muscle and Motion. The two cases are self-evidently quite parallel, and resolve themselves into that of Organ and Function, Mind or Sense being the special function of one structure and region of bodily tissue, as Motion is of another. So that the non-existence of soul or spirit in an ontological sense—for etymologically the terms mean only breath or life (soul), *i.e.*, the sum total of the organic functions—has been a settled question for nearly two centuries! It is the same thesis as that of a *Vital Principle* or *Archæus*, which all sound Medical Science has long since abandoned. It is another instance of the Phlogiston delusion so fatal to scientific Chemistry, yet clung to so fervidly by the discoverer of oxygen. All of sentient immortality, therefore, we can inherit is the sense, or idea, of it in our present body; which somatic entity, and not some "I know not what" of an impalpable

---

* I may here notice the virulent opposition to the "Atheistic Principles deducible from the Newtonian Physics," by John Hutchinson, author of "Moses Principia," who bitterly arraigned also Woodward's "Natural History" on the score of impiety. His sect, of which Bishop Horne and the Rev. Wm. Jones, of Nayland, were the most conspicuous polemics, became extinct only so late as in 1800.

Ghost or Spirit rector, is ourself. And surely this may suffice, seeing in every pulse beat we enjoy, or endure, according as we are well or ill,—the sensation of endlessness in time or space,—the feeling of infinitude being an *inner* one, as all feelings *must* be. It really is high time this pernicious and grotesque anachronism should, with other cognate anti-scientific *sciologies*, disappear from our lives which they deform. Reason cannot rule till all such are unsphered. On its very face animistic dualism is a detected imposture. For, as above insisted on, how can we coherently even imagine union between two such heterogeneous "substances," as an "immaterial principle," and a material organism?

Robert Lewins, M.D.

TELEPATHY.

Surely Dr. G. Wyld's objection to the theory that thought is transferred from one brain to another, by a process of undulation or vibration, is inadmissible! The various coats in which the brain is enclosed may certainly exclude the light-waves, but we know of no substance capable of excluding the magnetic vibrations. And there may be other modes of energy equally incapable of insulation.

Physicus.

INCONSISTENCY AMONG SPIRITUALISTS.

Though by inserting the recent article by R. M. N. you have almost overstepped your usual benevolent neutrality on the question of Spiritualism, you will doubtless not refuse to insert the following:—If there is one complaint more frequently urged by Spiritualists against men of Science than any other, it is that the latter dismiss facts on *à priori* considerations of what is, or is not, possible. Yet in a work which appears to be written by Spiritualists, and which many of them at all events approve of, I find it written—"When thy senses affirm that which thy reason denies, reject the testimony of thy senses and listen only to thy reason!" How are these contradictions to be harmonised?

A Lucretian.

"OUR INSECT ALLIES."

YOUR reviewer seems, in dealing with this point, to have overlooked a point of some importance. If, as the author contends, "there is no insect absolutely injurious to our interests," by a parity of reasoning, or of assumption, the same may surely be said of morbific germs,—nay, of vicious and criminal men.

The author argues further that noxious insects, commonly so called, are an annoyance only to civilised man, but not to the savage. This may, perhaps, be true as regards the locust, the potato-beetle, the *Phylloxera*, &c., but it does not hold good with the mosquito, the sand-fly, or the chigoe, which are as much dreaded by savages and barbarians as by the most cultivated nations.

NATURFORSCHER.

NOTES.

A METEORITE, probably of unique character, fell on February 14th at Hirschfelde, near Zittau. It consists essentially of iron sulphide. No nickel is present, and neither alkalies, silicates, nor metallic iron have been detected. It appears black, opaque, friable, and internally porous, though in some of the fragments there are distinct pyritic octohedra, and compact portions of the ordinary colour and lustre of pyrites.

At Yakutsk the earth, at all seasons of the year, is frozen from the depth of 15 metres to about that of 300 metres.

A new entomological journal is being published by the Brooklyn Entomological Society, bearing the curious title "Entomologica Americana."

At the Conference of the "National Union of Elementary Teachers," Mr. R. Wild, in his Presidential Address, assumed "over pressure" in schools as an evil well known to his hearers, and ascribed it entirely to the vicious system of "payment by results."

M. J. Héricourt ("Comptes Rendus") maintains that comma-bacilli, of the type described as "cholerigenous," are constantly to be found in all waters, of whatever quality and origin.

M. J. Ferran ("Comptes Rendus") asserts the possibility of prophylactic cholerisation by means of graduated doses of comma-bacilli.

Pasteur's method of vaccination for cattle-plague has proved completely successful in India for elephants, horses, asses, cows, buffaloes, and sheep.

The splendid Godeffroy Museum, at Hamburg, is in danger of being broken up in consequence of the death of its founder in very reduced circumstances.

M. S. Wroblewski ("Comptes Rendus") shows that the froth produced on the release of liquefied hydrogen has a temperature of −208° to −211° C.

MM. Fol and Sarasin find that a Monckhoven plate immersed in the sea received no impression at the depth of 420 metres. At 380 metres the impression was feebler than that obtained in the same time in a clear but moonless night.

A French writer ascribes the absence of trees in the Pampas to the destruction of their leaves by a leaf-cutting ant, to which he gives the name of *Opima spolia*.

M. Vulpian ("Comptes Rendus") questions the validity of the experimental evidence upon which Fritsch and Hitzig have concluded that the grey cortical matter of the cerebral convolutions contains distinct motive and psychomotive centres.

A perplexing fact is the appearance, and often the subsequent disappearance and reappearance, of aquatic plants in ponds and streams without any human intervention.

We are sorry to see "Spectroscopy" begin to appear as the name of a class of scientific research. It comprises a medley of astronomy, physics, chemistry, and biology.

According to Prof. Cohn, Leewenhoeck was the original discoverer of bacteria and bacilli.

The rainfall at Mooltan is only 5 inches yearly.

At the Lancaster Crematorium, in the United States, the charge for incinerating a human body is 35 dollars.

Says C. N., "It might not be a national loss, even though the accumulation of wealth were for a time subordinate to the search for truth, if eyes, from which the sunlight is now hidden by dingy walls of factories and warehouses, were permitted to rove onward and upward through the boundless heavens."

E. C. Mason ("Popular Science Monthly") states that last autumn the musk-rats built their winter retreats exceptionally light and unsubstantial, and have suffered much from the severe season. This fact disposes of the weather-foresight ascribed to this species.

According to M. Berthelot, carbonic acid in small doses acts as a powerful exciter of the absorption of oxygen.

The same *savant* declares that in our days "the world is without mysteries," although still "many enlightened minds remain entangled in the bonds of Spiritualism and Animal Magnetism."

A peculiar decomposition sometimes occurs in cheese, during which, if eaten, it produces symptoms closely resembling those due to irritant poisons. Such cheese may be at once detected by its strongly acid reaction with litmus-paper.

We have just made the acquaintance of a *Blaps mortisaga*, which, after being shut up with a quantity of potassium cyanide, and being considered as dead, has recovered, and is now well and hearty.

It appears that during last year both the death rate and the birth rate in London were exceptionally low.

A Bestiarian clergyman declared not long ago that "the meanest devil in hell knew more than the entire British Association." We can only congratulate the reverend gentleman on his evidently intimate acquaintance with the "meanest devils."

The "Medical Press" quotes with evident and justifiable scepticism certain alleged experiments made by "a physician at Denver" on revitalisation. A dog and a calf after being bled to death, and after remaining in that state respectively for three and twelve hours, were resuscitated by the transfusion of fresh blood, artificial respiration, and the injection of hot water into the stomach! It will be time enough to discuss the bearings of these results when they have been verified.

Lord Walsingham in his late Presidential Address to the Yorkshire Naturalists' Union proposed an explanation of the melanism prevalent among the Lepidoptera of high mountains. Those males whose colour enabled them to absorb the heat of transient gleams of sun most rapidly would be first on the wing, and would thus have the best chance of finding mates and consequently of transmitting their colour by heredity. The shorter the gleams of sunshine the greater would be the advantage of dark individuals.

Dr. Gerlach finds (Physik. Med. Soc. Erlangen) that an increased admission of air to eggs, effected by the careful removal of a part of the shell or rendering it thinner by filing, accelerates the development of the embryo.

The Entomological Society of France has awarded the Dollfuss prize to M. Léon Fairmaire for a work on the Hemiptera of France.

Dr. S. V. Clevenger is endeavouring to work out the proposition that "mental phenomena are modes of chemical energy."

M. H. Deslandres ("Comptes Rendus") finds that the spectrum of incandescent water presents bands similar to the absorption-bands of oxygen at low temperatures; moreover there are two series of bands and not a single one, and these bands in the vapour of water are considerably broadened.

The inscriptions chalked up on the walls of our streets, if not more refined than heretofore, are at least in better handwriting. Who, in face of such a fact, can question the success of our national "system" of education?

M. E. Verrier studies polydactylism, and the infranormal number of fingers, for which he has coined the horrible word "ectrodactylism." He is in doubt whether the occurrence of six fingers is to be considered as a progressive or a retrograde anomaly.

Since the virtual repeal of the Contagious Diseases Act the increase in cases of syphilis in the navy (home station) is 27·29 per thousand, and that of gonorrhœa 16·6 per thousand.

M. Timiarizeff ("Comptes Rendus") sums up the chemical and physiological effect of light upon chlorophyll as follows:—Chlorophyll acts as a "sensitiser," undergoing a decomposition and provoking the decomposition of carbonic acid in those regions of the spectrum which it absorbs. The different rays absorbed by chlorophyll affect its decomposition in very different degrees, the maximum decomposition coinciding with the maximum of energy in the normal spectrum. The shock given to the molecule of carbonic acid which effects its decomposition is due to the amplitude rather than to the velocity of the vibrations.

The "Lancet," discussing the increase of suicide, rightly ascribes it to the "fastness" of modern life, to "forced education," and to the increasing difficulty of existence.

The new "Poisons' Bill" has been referred to a select committee, and there is practically no fear of its becoming law during the present season. All persons connected with the chemical arts, or engaged in chemical research, should utilise this respite for organising resistance.

According to Professors Sedgwick and Nichols ("Science"), water-gas contains 30 per cent of carbon monoxide as against 7 per cent of the same poison in coal-gas. One per cent of water-gas mixed with air proved fatal to dogs, cats, rabbits, &c., in from five to eight hours.

Dr. Hellmann (Naturforscher) supports our view that an exceptionally mild winter is generally succeeded by an unusually warm summer.

Mr. J. N. Maskelyne, writing to Mr. E. Gurney on the celebrated "matter through matter" question, remarks that "it is easier to get a ring over the hand than to get it off again," and thinks that it might possibly have been got on "by well soaking the hand in hot water and bending the ring into a pear-shape."

Mr. John Hampden in his journal "Parallax," instituted to prove that the earth is a circular plane, calls Sir Isaac Newton "a fanatical pantheist."

2 MAY 1885

ERRATA.

Page 231, line 22, *for* lady-birds *read* aphides.
" " " 26, *for* does *read* do.
" 244, " 26, *for* Sach *read* Sachs.
" 248, " 19, *for* that *read* those.

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I. HOMER COLOUR-BLIND.

By Jabez Hogg, F.R.M.S., M.R.C.S., &c.

THE faculty of judging of colour with accuracy and precision may doubtless be considerably improved or augmented by education. But whether the colour sense has undergone any appreciable amount of change or development in historic times it is hardly possible to say. The Evolution hypothesis in no way assists in the elucidation of the question; no information whatever is derived from a retrospective examination of two or three thousand years or more, going back to the days of Anaxagoras, or of Homer. Hitherto Homer's biographers have failed to convince scholars that he, like our own Milton, was blind; others, with no better purpose, allege that he simply laboured under a special defect of vision, of a nameless character. More recently it has been said "that, judging by the colour epithets Homer employed in his poems, his organ of light and colour, and by inference that of the Greeks of his day, was only partially developed as compared with that of our own." Mr. Gladstone* first broached this theory, and his conclusions were based partly on the supposed defectiveness of Homer's colour vocabulary, which includes no epithet for either green or blue, and partly on the vague and not unfrequently contradictory manner in which he employed a large number of terms when writing of colour. A later critic† has undertaken to prove that Mr. Gladstone's views are altogether erroneous. The question, however, is not one of sentiment ; it is assuredly an intricate one, and difficult to decide, since many obstacles stand in the way of a satisfactory interpretation of evidence such as that furnished by the Homeric poems. On a careful consideration of the arguments employed by Mr. Gladstone, and those of his opponent in support of an opposite theory, I am led to think that the Homeric colour defect was due to a totally different cause to that suggested.

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* The Nineteenth Century, October, 1877.

† *Ibid.*, February, 1885.

In trying to arrive at a satisfactory conclusion on a subject of much obscurity, it is usual to base arguments on what is known with some degree of certainty through the results of science, experiments, and statistics, rather than on doubtful inference from theories not yet determined or positively ascertained. Mr. Gladstone's critic may, however, be unaware of the attention which has been bestowed of late years on a physical defect of vision,—colour-blindness,—and he consequently contents himself by arguing solely from words employed in ancient and foreign languages, the ordinary meanings of which are uncertain, while the subjective impressions which they describe are still mere matter of opinion. He nevertheless advances many interesting facts about the spoken language of India, which, by his showing, presents an identical meagreness of colour epithets with those which characterise the ancient Greeks. But collateral evidence of this kind will not enable us to determine whether Homer's defective colour vocabulary was really "one of language and not of perception."

Those members of the profession to which I belong, and who devote, as I do, much attention to defects of vision, will I believe find no difficulty in accepting the theory that Homer's defect was congenital,—was, in fact, a fault of perception, and not one of poverty of language. If the facts furnished by Mr. Gladstone were the only evidence, they would point to this conclusion,—and to this conclusion above all others,—*viz.*, that Homer was colour-blind. The vagueness of epithets employed by him to denote colour finds a close parallel in the language employed by those congenitally colour-blind. Such persons are not conscious of the defect under which they labour, and this very vagueness of adjectives about colour is at all times one of the common proofs of colour-blindness in testing railway-guards, engine-drivers, and others.

Mr. Gladstone tells us that Homer's colour sense was limited at the "stage at which red and yellow, and possibly deep purple, are definitely distinguished, but not green or blue. This is no uncommon experience of the red-colour blind.* When a railway-guard confounds together not only reds, greens, and browns, but also, as it occasionally happens, shades of violet and reddish purple, he is pronounced incompletely colour-blind. When, however, he further confounds all shades of colour, having the same intensity of light, his colour-blindness is complete. Judging from language alone, Homer, it would appear, suffered from an *incomplete* form of colour-blindness. In such like cases we are unable to appeal to a common or ordinary objective standard of comparison, or test, for determining the precise value of the colour epithets generally in use. Although with the major part of mankind colour is entirely a matter of subjective impression, the colour vocabulary is, most assuredly, capable of educational improvement. On the other hand, colour-blindness is purely a physical defect of an intractable nature.

Some confusion and a certain amount of annoyance were occasioned, a few years ago, by the published conclusions of one who believed himself to be a connoisseur of pictures, but whose unfitness for the task consisted in his being colour-blind.

Dyschromatopsy, partial colour-blindness, is known to be prevalent among civilised nations. Mr. Gladstone's critic is probably aware of this, although no mention is made of so important a fact, he seemingly preferring to discuss Homer's defective colour system—or, as Mr. Gladstone prefers to put it, "his system in lieu of colour, since it was based upon light and its negative darkness rather than on colour proper"—entirely from a philological point of view, nothing daunted by the formidable character of the obstacles which "stand in the way of a perfectly satisfactory interpretation of the evidence furnished," meaning furnished by Philology alone. Homer, he infers, possessed a certain sense of colour redness, because he frequently employed the word *eruthros;* but as the adjective *red* is frequently used to denote other colours than red, this must be taken simply for what it is worth. To know that "wherever the Hindustani language is spoken *red* is used to designate a great variety of natural objects,—that horses, dogs, cows, tigers, lions, monkeys, in short all animals of a brown or reddish brown colour, are called red, and if of a darker brown (or even blue are called black: these are facts of interest to naturalists as well as philologists, but they do not assist us over much in the interpretation placed by scholars on the peculiarities of the Homeric colour vocabulary. It is quite unnecessary to go to India for parallel examples and incongruities of colour epithets, as our own vocabulary and the usage of our own people furnish examples enough. In many agricultural districts brown and reddish brown cows, of all shades of colour, are spoken of as red cows, purple berries as black-berries, and so forth. This form of speech is in no way conclusive of a meagre vocabulary: it is simply a conventional defect of language, a provincialism, which has lingered among the bucolic populations of this country for ages, and it is only to be got rid of by education or by mixing with urban peoples. It is no better proof of a limited or defective colour vocabulary than is the slipshod clipping of words so common among us, and which is excessively bewildering to the intelligent foreigner. An idiomatic phraseology is thought to be in no way significant of any meagreness of vocabulary among civilised nations. With reference, however, to the extent of the colour vocabulary especially, it is a fact that the colour sense can, equally with the other senses and with language as a whole, be cultivated and improved by education.

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* "White light for the red-blind person is a mixture of the two primary colours in proportions which would appear to the normal eye a greenish blue, verging on black."—HELMHOLTZ.

The aboriginal races of the Earth have heretofore exhibited great ignorance of colour, and their vocabularies are consequently of a very limited nature. But this was not the case with the Greeks of Homer's day, nor of the earlier Eastern races, whose love of colour has been unmistakably made historic in their textile fabrics, mosaics, and frescoes, which have been so wonderfully preserved as a proof of a fully-developed colour sense.

A very large number of our lower class of workmen are quite unable to name colours correctly. Their colour vocabulary, on examination, has been found to be extremely limited. Some trades seem to exert a deteriorating influence: for example, the men working in a gas-factory were examined as to their acquaintance with colours; sixty-five stokers were tested, and twenty-four of them were found colour-blind. Of ordinary working men, a little higher in the social scale, a considerable percentage were discovered to be ignorant of colours. Of 268 soldiers tested only 163 exhibited an intelligent knowledge of colours, while 73 named them indifferently well, and 39·18 per cent were unable to discriminate perfectly between red and green, the majority being, in fact, red-blind. On one of the French railways, where all candidates for employment are very carefully examined as to their colour vocabulary, of the 1050 applicants between the ages of 18 and 30 examined, 98 were rejected because of their ignorance of colour: a number of these, however, on closer examination, were found to be fairly able to distinguish the difference between red and green,—the two most important signalling colours on railways,—and only a small percentage were finally rejected.

The average percentage of colour-blind, among all classes of men, is 3·5 per cent; of women, only ½ per cent. Among the seafaring class the percentage is also remarkably low. From a Parliamentary Report, issued in 1879, of the examinations of candidates for masters' and mates' certificates in the Merchant Seamen's Service,—and which, oddly enough, are made compulsory on all alike, *except pilots*,—the percentage of colour-blind is given as 0·43 per cent (rather under a ½ per cent). But it appears that, as failures were often reported from ignorance of the names of colours and other causes, those rejected were allowed to present themselves a second time, when a third of the whole number passed the colour tests.

From a later return (1884), moved for by the Member for the University of Oxford, at my instigation, we derive other facts regarding the Mercantile Marine. Of the 85 candidates examined, no less a number than 79 were unable to distinguish a difference between green and red; 38 mistook yellow for red; 45 called blue, green; 16 called yellow, green; 4 black, green; 3 white, green; while others called dark green, yellow,—and blue, red. But, remarkable enough, rather more than a third (29) of the whole number examined, on presenting themselves a second time, obtained certificates from the examiners at other seaport towns, one only succeeding in London.

Colour-blindness, like other defects of vision, affects people in different degrees of intensity, and, like myopia or short-sight, it is frequently hereditary. In several instances I have witnessed its transmission through three generations, and it often becomes more pronounced in after-life, or when the near point of vision begins to recede.

It will be seen, then, that a statistical comparison of defects of perception of colour is always of importance, and especially so when discussing the obscure question of a meagre Homeric colour vocabulary. We might with advantage pursue the inquiry of a defective colour sense to the better educated classes, to men of culture, and who, it will be seen, more often suffer from the evils involved in a partial loss of the colour sense. Among the more highly educated of all nationalities the average number of colour-blind is 4 per cent, an average in excess of that of all other classes. A man may have a good eye for form and outline, and yet be partially or wholly colour-blind. To select an instance from among many is difficult, but one impresses me more than the rest,—that of Wyatt the sculptor, who at the outset of his career was known as a remarkably good draughtsman. He naturally took to painting, but, as his pictures were observed to present curious incongruities of colour, that involved him in grievous difficulties, he with much reluctance was obliged to abandon the brush for the chisel. He was altogether unable to comprehend the nature of his defect,—indeed refused to believe that he was colour-blind. So of men who have attained to eminence in the world of letters, and whose writings unmistakably betray evidences of a meagre colour vocabulary. A striking example of this occurred in the person of my friend the late-lamented Angus B. Reach, whose life, alas! was prematurely shortened by over-work—brain-disease. He was unable to recognise a difference in colour between the leaf, the flower, and the fruit of plants and trees. His want of perception of colour was wholly unknown to, and unrecognised by, himself, until we sat together at the table of a Paris restaurant. He, wishing to finish his letter to the "Chronicle" newspaper, requested the waiter to bring him some ink. As it often happens, under similar circumstances, the ink was brought in a wine-glass. Reach became absorbed in his subject, while I, seated opposite to him, observed him alternately dipping his pen into his claret-glass and into the ink-glass. I frequently checked him, but presently to my surprise he took up the ink-glass and was about to drink, when I remonstrated, and he then said he could see no difference between the colour of the ink and the wine. On subsequently testing him I discovered that he was completely colour-blind.

From an examination of the Homeric colour sense, as indicated by Homeric colour epithets, and as resting on a scientific basis, and also from a statistical point of view, I venture to suggest that Homer was colour-blind. Indeed an analysis of the Homeric colour vocabulary strongly points to this conclusion. Homer certainly laboured under a physical defect of vision, and this fully explains the limited use of the terms he employed to express his sense of colour, and to which Mr. Gladstone has drawn attention.

II. THE FORM OF THE EARTH.

By Major-General A. W. Drayson, F.R.A.S.

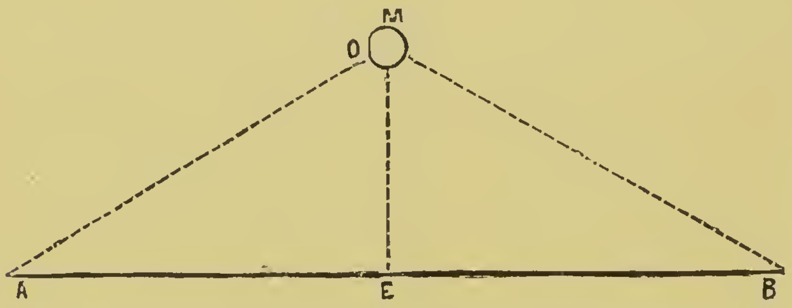
IT is generally allowed by all thinking men that those subjects which have been taught us in our youth, and which have been accepted without investigation, because presented to us under the influence of authority, are very likely to be incorrect.

There is a natural tendency in the human mind to follow in the beaten track, and when once any problem has been accepted as correct it is very difficult for us to get rid of the prejudice which we possess in its favour. Consequently error is too often perpetuated by the teaching of the schools, and that which, if a novelty, would be examined in a careful and critical manner, is merely accepted as an article of faith, not of reason. When this article of faith is questioned, or doubted, by a reasoner, he not unusually causes irritation in the mind of the man who has accepted on Faith. Arguments, proofs, or demonstrations, produce little or no effect, and the erroneous teaching is handed down from generation to generation. To be able to *prove* that which we believe is therefore of the greatest importance, and the first demonstrations here given will refer to the form of the Earth.

Even in the present day there are a few persons who assert that the Earth is not spherical in form, but is flat, and they state that the apparent changes in position of the celestial bodies can be satisfactorily accounted for if the Earth is a flat surface.

There is no science which is more rigidly accurate than Geometry. The laws referring to circles, spheres, triangles, &c., are immutable: it is not unusual therefore to find impostors in Science, or those who are merely veneered in Science, sneering at Geometry, because such men would prefer that theories and opinions should take the place of facts. More especially is this the case when such men have gained a reputation for their visionary theories, and fear that an investigation of the rigid laws of Geometry will prove their theories untenable. Men who assert that the Earth is a flat surface will listen to no geometrical proofs. Men who make assertions relative to other supposed forms or movements of the Earth endeavour to ignore Geometry, which is too exact a science for them. The geometrician, however, *knows* his science is unassailable, and that no opinions or theories can controvert the facts and laws with which he deals.

Individuals who assert that the Earth is a flat surface bring forward the following as a proof that the known facts can be accounted for thus:—They say the moon, for example, may appear 30° above the horizon and to the south of a person in 60° N. lat. It may, at the same instant, appear in the Zenith of a person at the Equator; and it may, at the same instant, appear 30° above the horizon and to the north of a person in 60° S. lat. But, say these persons, these facts do not in the least indicate that the Earth is round, because these changes can all be accounted for if the Earth is flat; and they give the following as an example:—



Suppose M the moon, A E B a portion of the Earth and a flat surface; A a locality 60° north, E the Equator, B a locality 60° south.

The Moon as seen from A will have an altitude of E A M, say 30°; at E the Moon will be in the Zenith; at B the Moon will have an altitude of E B M, = 30°. Therefore, say these individuals, the fact of the Moon being at different altitudes is no proof of the Earth being spherical in form. Geometry now comes to our aid to prove that a certain result would follow if the Earth were a flat surface, which it is known does not occur. The line M E would represent the sine of the angles M A E, M B E, whilst A M and B M each represents the radius. Consequently, as the angles M A E and M B E are each 30°, the sine M E is equal to half M A or M B. Consequently the Moon seen from A or B would be at double the distance from either of these stations that it is from E. Consequently the Moon would appear to an observer, at E, to have twice the diameter that it would appear to have if seen from B, or A.

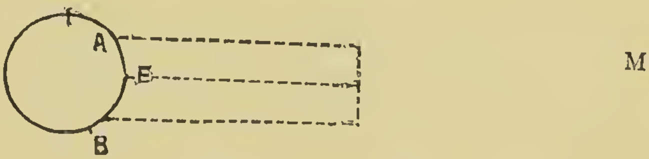
But the Moon, whether seen overhead from the Equator or 30° above the horizon from a locality north or south, appears not half the diameter that it appeared at the Equator, but as nearly as possible the same diameter. Therefore the assumption of the Earth being a flat surface is contradicted by facts.

Again, if the Earth were a flat surface, an observer at A would see a crater at O in the centre of the Moon; whereas an observer at B would not see this crater at all, as it would be on nearly the opposite side of the Moon to that which the observer at B would see. If, then, the Earth were a flat surface, these observers in different parts of the Earth would see a different portion of the Moon; but such is not the case: consequently Geometry proves that the assumption that the Earth is a flat surface is erroneous.

Now what are the conditions that must be fulfilled as regards the Moon when seen from the Earth. They are as follows:—

1. An observer in 60° N. or S. latitude must see the Moon 30° above his horizon, at the same instant that an observer at the Equator sees it at its Zenith.
2. The observer north and south of the Equator must find the diameter of the Moon of nearly the same value as it is to an observer at the Equator.
3. The three observers above named must see exactly the same "face" of the Moon.

To account for these three facts we have the following diagram:—



A, an observer north of the Equator, sees the same face of M, the Moon, O as is seen by observers at E or B.

The moon, M, is vertical to an observer at E, and 30° above the horizon to the observers at A and B.

The diameter of M, the Moon, will appear as nearly as possible of the same size to each observer at A, E, and B, because the difference in the Moon's distance from these three points is very slight.

Here, then, we have every known fact connected with the Moon explained by giving to the Earth a spherical form, whereas if we assume the Earth to be a flat surface we must have certain results occurring, *viz.*, the varied appearance of the Moon's surface and the varied size of the Moon, which we know do not occur.

We need not therefore measure along canals, or apply any such trifling tests, to prove that the Earth is spherical, when Geometry, by aid of the Moon, proves what the form of the Earth must be.

In order to attempt an escape from the preceding geometrical proof, the advocates of the flat surface theory have asserted that the Moon also is flat and shaped like a coin, and therefore only one side can be seen by people in different parts of the Earth. Geometry again proves that this assertion must be incorrect, because if the Moon were in form like a disc it would appear circular in form to a person who was exactly under the Moon, but it would appear elliptical in form to those persons who saw the Moon at any other altitude than exactly overhead.

In these cases we have admirable examples of the power of Geometry to prove or disprove the theories, or assumptions, of visionary schemers. There is a great tendency in some minds to start some theory, and then to cook facts and evidence to make this theory appear correct; and it not unfrequently happens that individuals who thus act imagine they are following out the rules of exact science in what they do. As an example of this peculiarity the form of the Earth may again be taken.

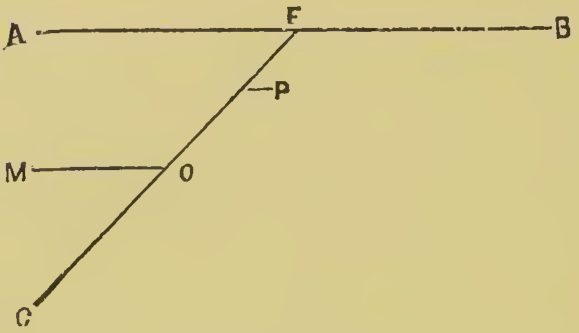
The Earth, it is stated, is not a sphere, but a spheroid. It is flattened at the Poles; consequently the Polar diameter of the Earth is less by several miles than the Equatorial diameter. Now if it be stated that this spheroidal form of the Earth is merely a theory, hundreds of so-called scientific men would probably be annoyed at the ignorance of any person who could make such an assertion, for they would probably state that not only was the Earth proved to be spheroidal, but the actual length of each degree of latitude had been calculated to within one foot. It is quite true that each degree of latitude has been calculated to a foot, but this calculation is based on the theory of the Earth being spheroidal and there being a certain proportion between the Polar and Equatorial diameters.

The actual facts relative to this theory having been so long considered a problem most satisfactorily proved, may now be described.

It was, and is, assumed that the Earth in its most ancient condition was in a fluid or molten state. It was again assumed that whilst it was in this fluid state it began to rotate on its axis. Then, on the suppositions above named, the rotation of the Earth would cause the sphere thus rotating to become a spheroid, and to become flattened at the Poles, and to have a longer diameter at the Equator than at the Poles. An air ball is then made to rotate *rapidly*, and as it does so it assumes a spheroidal form ; and this experiment is supposed to be a proof of the Earth being spheroidal in form. A geometrical proof, however, was needed, and this proof was that a degree measured in any meridian near the Equator was shorter than a degree measured near the Poles. In order to obtain evidence of this nature, astronomers and surveyors were employed in various parts of the world to measure arcs of the meridian, and it has been stated these observers proved by their measurements that the length of a degree near the Equator was shorter than a degree near the Pole. And this problem is now considered to have been solved without the slightest possibility of error.

With regard to the last-named evidence it may probably surprise some of our readers when it is stated, first, that the astronomers and surveyors did not prove what it is stated they did prove ; and, secondly, that at the time the observations were made the class of instruments used were such that these observers could not prove what it is claimed they did prove.

If we now examine this problem critically, we find that it is first based on two theories. It has been assumed that the Earth was once in a fluid state. The evidence on which this theory is based is very questionable. We must not therefore accept this theory as an established fact. Was the Moon once in a fluid state ? if so, when did it begin to solidify ? for it is certainly solid now, at least on its surface. If the Earth were once in a fluid state, and heated, and then cooled down, the surface that had cooled down would show evidence of *contraction*, and we should find evidence of this contraction in the "faults" in strata and mineral veins. *All* the faults, however, as is well known to miners, give exactly the opposite evidence. If a fault be found in any vein, the continuation of that vein is never found in the position it would occupy if the Earth's surface had contracted, and the fault had been produced by contraction. Thus if A B be a portion of the Earth's surface, F G a fault, M O a vein of metal, the vein disappearing at O in the fault, the continuation of this vein will be found at P, or at some point between O and F, and is *never* found to be continued between O and G, as would be the case if the surface of the Earth had contracted. The value of this fact cannot be over-rated. To the reasoning and geometrical mind it is



convincing, but on schemers and visionary theorists it produces no more effect than does the geometrical evidence relative to the Moon on those persons who assert that the Earth is a flat surface.

Then we have another theory based on the first-named theory, *viz.*, that when the Earth was in a fluid state it rotated on its axis; and because an air ball when rotated *rapidly* assumes a spheroidal form, therefore the Earth is spheroidal. Now the Moon is certainly solid on its surface, but rotates once only during about twenty-seven days. It is a mere guess, then, that the Earth rotated rapidly when it was assumed to be in a fluid state. But there is another doubtful question connected with this theory, *viz.*—If an air ball rotate once during twenty-four hours, this rotation would not cause the air ball to assume the form of a spheroid; it is only when it is given some hundred or more rotations in a minute that it does assume such a form. If, now, an air ball were 6 inches, 6 yards, 6 miles, or 600 miles in radius, would a single rotation during twenty-four hours cause this ball to assume a spheroidal form? To spin a ball rapidly, and then to assert that, because this ball assumes a spheroidal form, therefore the Earth is spheroidal, is a false and unsound conclusion, although it is one very readily accepted by the superficial reasoner.

But, it may be stated, accurate measurements have proved that a degree of a meridian near the Equator is shorter than a degree of the same meridian near the Poles. The proceedings connected with these measurements offer an excellent example of that vicious method of cooking facts to suit theories, or the dogmatic opinions of authorities, which cannot be too strongly condemned.

It having become an accepted and popular theory, that the Earth when in a fluid state had rotated on its axis, and as a consequence had assumed a spheroidal form, it was decided that arcs of the meridian should be measured in various parts of the world, in order to prove the accuracy of the theory. Now let us ask what the observers who were sent on these expeditions were expected to accomplish? They were expected to measure a base line, and from this base line to extend a triangulation to the extent of nearly 70 miles. They were then to determine two points north and south of each other, which were exactly 1° apart.

Let us first deal with the surveyors' part of the work, *viz.*, the measurements, and we find that the surveyors had to measure 365,000 feet without an error of 1000 feet, or even 100 feet. This in itself is a work of great difficulty, and one which the surveyors of former times, especially in a rough country, could not fairly accomplish.

Next we have the astronomical problem to consider. The latitude of two points is to be ascertained to within 1″, and with portable instruments. What are the probabilities of this being practically accomplished? With the most perfect instruments, and thousands of observations made each year, the latitude of Greenwich Observatory fifty years ago was 2″ in error; that is, the latitude then assigned to the Observatory differed 2″ from that which is now assigned to it.

A second of latitude may be taken as about 120 feet,—consequently 2″ would be about 240 feet. This error at each station would amount to 480 feet, and this error might occur after a hundred years of observation and with the most perfect instruments. A far greater uncertainty must exist when observations were made during only a few months, or years, and with instruments inferior to those now in use at Greenwich. To claim, therefore, that observers one hundred years ago proved that a degree of the meridian measured near Peru or at the Cape was a certain number of feet shorter than a degree of a meridian measured in England, is one of those pleasing but visionary delusions in which theorists too often indulge.

But a far more amusing delusion exists in connection with certain measurements made in former times to ascertain the tenth millionth part of 90° of latitude. The French being anxious to introduce an exact standard of measure, *viz.*, a tenth millionth part of the arc from the Equator to the Pole, employed several surveyors and astronomers to measure arcs in various parts of the world. These observers, as was naturally to be expected, differed in their results. The principal rivals were M. Borda and M. Bouguer. M. Borda made the metre 3·0807 of the "Pied de Roy"; but M. Bouguer made the metre 3·0794. The latter gentleman it appears had friends at court, and, lest the learned men of the time should have any doubt on the question, M. Bouguer's measurement was settled by an Act of the Legislature to be accurate (!) and M. Borda's wrong, and thus the French metre was established as the most accurate standard in the world, but not by any scientific proof.

Another experiment was carried out some years ago to obtain, as was supposed, additional evidence that the Earth was spheroidal in form, *viz.*, experiments with the pendulum. The results of these experiments, however, have not been of such a definite character as to be satisfactory, except to those theorists who have already come to the conclusion that the Earth must be spheroidal in form *because* it rotated when in a fluid state.

That the Earth is spheroidal in form is possible, but the evidence claimed as proving this is either mere guess or the arbitrary assumption of authority. The assertion that the Earth was once in a fluid state is a guess, disproved by the facts known to exist in connection with "faults" in mineral veins. That the Earth rotated when in a fluid state is another guess, based on no evidence whatever. That the surveyors and astronomers of the past proved that a degree of latitude near the Equator was shorter than a degree near the Poles is claiming that these surveyors with portable instruments, and during a few months, obtained more accurate results than had been obtained at Greenwich Observatory during a hundred years.

The question as to whether the Earth is spherical or spheroidal is not one of very great importance, but the manner in which this problem has been dealt with in former times supplies us with an example of the unscientific and prejudiced manner in which some theories are considered to be satisfactorily proved.

That the Earth is spheroidal has never been proved. That the Equatorial diameter exceeds the Polar diameter by a certain number of miles, yards, and feet is a theory only not corroborated by actual facts, though certain assumed evidence has been cooked to agree with the theory. Those persons who can believe that the Earth has contracted, in spite of the evidence shown by the faults in mineral veins, occupy a similar position to those who assert that the Earth is a flat surface, in spite of our seeing only one face of the

Moon; they cannot appreciate the force of an impossible, but cling to a theory, and a preconceived opinion, in spite of it. The manner in which geometrical facts are ignored by many men in the present day, and mere visionary theories are put forward as realites, teaches us that we are in great danger of committing the errors of the ancients, who claimed to know the influence produced on the seasons, and on men's destinies, by the various planets, but were totally ignorant of the form of the Earth or that it rotated on its axis. Theories based on facts are probabilities, but when theories are first started, and then facts are arranged and selected to confirm these theories, there is a great danger of delusions being established by "authority," and of error being taught as truth.

III. SOUTH GEORGIA.

By the Count O. REICHENBACH.

THE observations there made by the German Expedition have surprised scientists. The island lies—64 miles long by 30 at the widest—in 36° 5′ W. long., between 57° 31′ and 55° 10′ S. lat. The Expedition remained 352 days, from September 15th, 1883, to September 3rd, 1884. Its station at Royal Bay was surrounded by mountains, with huge glaciers, 900 to 1200 feet high, rising farther inland to 6000 and 7000. No month was free from frost; 30 per cent of the hours of observation showed a temperature below freezing-point. The mean temperature for the 353 days, which would have been slightly increased by the 12 wanting to the year, was 1·666° C.; for February, the warmest month, 5·35° C.; for June, the coldest, −3·22° C. The maximum reached in February was 14°; the minimum in July −3·22°.

In 1880 I wrote ("On some Properties of the Earth")—"At the isotherms of 1·666° C., of which that at the South is quite maritime and almost without curving, the equilibrium of temperature between South and North is re-established; the isotherms coincide, each in its mean, in both hemispheres, with their bases or parallels; they divide the hemispheres in proportion 1 : 4·78," in 55° 48′ latitude. The island with its glaciers produces a bend of only 1° 7′ of latitude towards the Equator in the isotherm of 1·666°.

The Rev. Professor Samuel Haughton, in "Six Lectures on Physical Geography, 1880," gives, on p. 108, the temperature for 55° 48′ S. lat., 4·78° C.; for 54° 31′ S. lat., 5·29° C.; for 36° 5′ W. long., even 1·22° C. higher.

The mean temperature of the globe was generally given, according to Dove, 14·44° C.,—15·55° for the northern, 13·33° for the southern hemisphere. I made the mean for the globe 15·22°, and the temperature for the two hemispheres equal. Of late I met the figure 15·22° for the globe; by whom determined and by what method I did not see.

The range in South Georgia between the coldest and warmest month was only 8·77° C. What I said of the Antarctic meteorological zone, after having shown that its mean temperature is higher than that of the Arctic, applies to this Sub-antarctic region. "It is generally thought that the Antarctic regions are considerably colder than the Arctic. Those navigators who penetrated farthest in the Antarctic regions did not support this view; the animal life of its seas contradicts it. Remoteness, the low temperature of the warm season, which does not prove the great cold of the long nights, and the imposing icebergs and masses of pack-ice, have produced wrong impressions."

IV. ON THE CELLULAR AND EXTRA-CELLULAR TRANSPORTATION OF NUTRIMENT.

IN consequence of prolonged researches on the absorption and assimilation of peptone, Dr. F. Hofmeister arrives at the following conclusions, which he has given to the world in the "Archiv für Experimentelle Physiologie":—

The absorption of peptone in the intestine is no simple mechanical process of filtration or diffusion, but a function of definite living cells, the colourless blood-corpuscles.

These play, in supplying the system with albumen, a part similar to that of the red globules in respiration. The "Naturforscher" summarises the theoretical outcome of the author's results. His conclusions are of the greater importance as showing that not merely the transformed albumen or peptone, as proved by Hofmeister's researches, and the oxygen, according to less recent observations, but, as it has been shown by Wiedersheim and others, the fat in the higher animals and all the nourishment in the lower forms,—even, according to De Vries, the nutritive matter for plants,—are taken up by cells, or by protoplasm, and thus transported to the parts where they are required.

The continued wear and tear to which the organs of the animal body are subjected necessitate a constant supply of fresh material, as such serve the manifold nutritive substances which are conveyed from the digestive system to the blood, and by it to all the organs. According to the general view these food matters on the way to their destination exist in the state of simple solution, or, in the case of fat, as emulsion. The impelling forces which convey them to such cells as are in need of support are simply the circulation of blood and diffusion. That any portion of the nutrient principles can become temporarily or permanently part and parcel of movable cells, in the coats of the intestine or in the blood-vessels, and can thus carry out the function in an organised form, seems, according to this view, simply excluded. This supposition, however, extends merely to the nutriment introduced through the medium of the digestive organs. For the portion of nutriment taken up through another channel, *i.e.*, the oxygen, Science has long ago come to a very different conclusion, as far, at least, as the higher animals are concerned.

The small quantity of oxygen which can exist in the blood in a state of simple solution cannot even come into consideration as a source of this essential. A sufficient supply and a proper distribution are effected only by the circumstance that the blood-discs become charged with oxygen in the lungs and deliver it again at the places where it is required. Blood containing no discs would be quite incapable of transporting oxygen from the lungs to the other organs.

Dr. Hofmeister, for the sake of brevity, terms that mode of conveying nutrition which involves the co-operation of figured elements "cellular transfer." If the supply is effected, in accordance with the common view just expounded, without the co-operation of cellular elements, this would be "extra-cellular transportation."

That the difference between these two forms of the conveyance of nutriment is not merely theoretical, but involves an essential difference in our conception of the process of nutrition, will appear from the following simple consideration :—Nutrient matter dissolved in blood or lymph, and consequently circulating in an extra-cellular state, must naturally follow the existing currents of liquids, in as far as the laws of diffusion and filtration permit. If they have been taken up by the blood, they are conveyed by it to all the organs in one and the same degree of concentration. Along with the transuding phasma they permeate every tissue, whether it requires them or not, and arrive finally in the organs of secretion. Whether they are held back at these points of exit, or find a passage and are thus lost to the organism, depends only on the arrangement of the secreting apparatus and on its condition for the time being.

Very different must be the behaviour of nutrient matter which enters into the circulation in combination with cells. Here there is no question of their uniform distribution in the liquids of the body. The cells containing nutriment are small, itinerant magazines, in which relatively large proportions of nutrient matter are heaped up in a single point. They are not at all subject to the laws of diffusion, and obey the existing liquid currents only within narrow limits. If they have no inherent motive power the coats of the vessels present to them an impassable limit ; but if they have an automatic motion, and are capable of travelling, they are, when outside the current of the blood, to a great degree independent of the air-current. In either case there is the possibility of supplying the organs with nutriment exactly as required. To fulfil this condition we need merely, in the former case, suppose that the circulating cells charged with nutriment give up their cargo to the surrounding tissues through the capillary lining to such an extent as it is required. Tissues which for the time being do not require a supply are simply passed over in the distribution. Such an arrangement, we know, prevails in the supply of oxygen to the tissues.

In the second case, if we admit that the nutrition-carrying cells are capable of travelling, the affair is still simpler. The cells can arrive directly at the place required, and can be utilised either with their entire mass or only with a part of their cargo. This arrangement, even more than the first case, permits the direction of large quantities of nutriment to single points in particular need of a supply. This arrangement appears realised on a pathologically enlarged scale in the emigration of the colourless blood-corpuscles in cases of inflammation.

The cellular combination of nutritive matter explains very simply the formation of receptacles for reserve-matters in which, during a time of superfluity, the nutriment taken up is stored in an organised form, so as to be at the disposal of the organism in times of need without the necessity of previous important chemical transformations.

"Cellular transportation" is exceedingly important for the conveyance of matters insoluble in the liquid of the blood, and therefore incapable of diffusion. The difficulty of conceiving the entrance of such substances into the tissues appears at once annulled if we assume that it is effected through the mediation of transportable cells. This comes into play for the transfer of medicines and poisons perhaps even more than under normal conditions.

The greatest advantage, however, of "cellular transportation" is that it prevents a waste of the nutritive material which has been secured for the organism. We know that many very important nutrients (sugar, peptone, &c.), if they are introduced directly into the blood, even in small quantities, they are expelled through the secreting organs, whilst on the reception of much larger quantities of the same substances by way of the intestine, under physiological conditions, nothing similar is observed. This different result appears scarcely conceivable if we assume that nutriment is conveyed to the organs in the state of solution; but if we suppose a cellular combination it seems not merely intelligible, but a matter of course.

As regards the manner in which the nutrient matters in cellular combination are distributed at the places where they are needed, Hofmeister points out that already many circumstances are known which indicate that the amœboid movements of the cells are affected by various conditions, and possibly by the absence of those matters of which they contain an excess. Here further experiments and observations are requisite. The "Naturforscher" refers here to the experiments of Pfeiffer in which the direction of the movements of spores was effected by the chemical character of the surrounding medium.

Finally, Hofmeister intimates that the conveyance of nutriment may be both cellular and extra-cellular. Even in cellular transportation processes of difference between cell and cell may not be wanting, and extra-cellular transportation

—as it is admitted in the cases of water and salts—will fall transitorily under the influence of the cells. To what extent, and for which kinds of nutriment these two modes of transportation come into play, can be determined only by experiment.

V. THE CONCEPTION OF IDEAS AND THE PROGRESS OF THOUGHT.

By D. Y. Cliff.

IT is curious to consider what the first thought was like: was it transitory, or a beginning that had no break? The old Semitic idea is that man "awoke" to thought, but of such a nature that it could not distinguish "good and evil;" on attaining that much discernment it saw that man must "surely die:" man recognised himself amongst Nature generally as a passing guest. Though the first origin of thought cannot perhaps be traced, yet it is not impossible to follow historically distinct phases of development (or alteration); and more vaguely to get at something like a ratio of time to progress. Suppose that man's development had not taken a self conscience mental turn; supposing him still to have survived with his inherent tendency of progression, what would have been the result but a spended evolution of idleness? Idleness had evolved a being who was superior to all accidental and surrounding forces,—a naked creature probably living on air, &c.

But what is an unconscience existence but a non-existence so to speak? Nature exists to us, but not to itself. And as only the mind makes us aware of its existence, it is not quite an empty, though strange remark, to say—mind actually creates matter. What is the object of Nature's existence when it is unknown to itself? Our minds are the minds of all matter; and a consequence of it. If matter does exist, it must, one would think, have been prior to thought; but if mind creates matter then both (*e.g.*, to use words) simultaneously appeared: for what is one without the other? To the body-sensuous "the spirit" is non-material, and so to the mind the body is untangible. However, man has become aware that he *is*, and it is generally thought has allowed his mental proclivities to overreach his physical devolopment, altering, perhaps, even that from its original path. Man has attained to the conception of the immortal. This to my mind lends favour to the theory of prëadamite races. Perhaps once thought and memory passed to the child, *i. e.*, the crude consciousness of an existence. The hazy mind in the long, long life of brute man probably could not pass back to its beginning. A dim idea of the everlasting would impress itself on his progeny: and as he became more "awake" it would be constantly impressed on him by the permanency of Nature, by the unpierceable heights of the silent blue above, and the unbound and unconceivable expanse of the ocean at his feet. Then he tasted of the tree of life and realised that he must die, but he could not conceive that he should drop out of time. But, in spite of what is often said to the contrary, I do not think the idea of immortality is intuitive.

But let us turn to actual facts. We find that the mind varies in different races, but that certain stems are common to all their diversities. It is observable in the expression of the face; in the gait; speech; grammar; expressions and phases of thought; illustrated in art, literature, manners, dress, fancies, religions, and so forth; the most striking being those apparent to the eye, their handcraft, and their social doings. To this we trace the reason why no religion can be universal unless the whole be inhabited by one race.

Nor are peculiarities matters of accidental growth—this is contradicted by their constancy in variation. Thus the oriental does not only differ in choosing to consider his left hand the place of honour, but his book reads doubly backwards, and even his letters slant in an opposite direction. Yet this oppositeness does not extend to physical facts, such as being left-handed for instance, which is a proof of its subsequent development, or mental divergency. The straight line or a circle is the same thing to all men, though they may vary in the direction in which they draw them: we might say it is the fact of *order* impressed on the mind.

This suggests an inquiry: how have our notions of rectilineal lines and perfect circles become impressed upon our minds, when in all Nature it is far from the rule and scarcely perceptible ànywhere? It is the exception. The sun is round, and so is the iris of the eye, but where are the vast quantity of horizontal, perpendicular, and parallel lines that haunt the human mind, and result in order—so absent in Nature generally? Is it merely a matter of survival? He who threw his weapon straightest, he who made for the shortest distance between two points, and so forth? Animals, though, seem to have this consciousness, though perhaps an insect does not. But can any historical improvement in a race be traced? I think so. I am most certainly inclined to the belief that old sculptures, paintings, &c., stiff crude, or whatever else they may be, represent the exact state of the mind of the people amongst whom it was produced, otherwise it would have been detected and corrected—must have been. On these grounds I should say the old Egyptian was "his beard over again;" and the stiffness of the Assyrian designs actually existed in their intercourse and modes of thought: their literature would be the same. This is why the Greeks were alike beautiful (according to our conceptions) in their face, their art, and their writings. Is it not known that the old oriental music was wildly discordant and meagre? But with the Aryan Greek did not her earliest poet know the power of the Syren's music? At last the mind had broken free: unfettered it scudded before the wind of fancy and taste whither so ever it would: thought flowed easy, and so consequently the fold of the garment on the statue and the pen of the poet in his verse. Can we trace the pure descendants of these Assyrians and Egyptians? What is their artistic taste to day? Can a Hindu whose fathers carved the uncouth monsters scattered over the land of India *now* paint like a European or attain any excellency in sculpture according to European standards of judgment—beyond mere imitation? I have not the information: but in case it is so, which I am inclined to doubt, the question of a development in the Hindu mind is debateable. It is possible from religious prejudices or erroneous fashions to adhere to old conceptions of beauty long after common sense scorns it. The differences strike me as mental incongruities rather than faulty or uneducated manipulation.

Then if we turn more particularly to architecture since Christ's time for a visible exhibition of the mind of nations we are impressed with various thoughts. To me they all tell their story. It is said that the Gothic pillars may be continued any length without destroying the beauty of the effect. Is this not a visible exhibition of the latent ideas floating in the mind of the principles of Christianity "looking heavenwards?"

The Gothic architect stands beneath and between pillars that tower away heavenwards; he is essentially at the *bottom*, just in the same way the eye of the Norman architect is in the *middle* of his arch; and though it may be fanciful, I think the Byzantium horse-shoe arch shows that the architect's eye looked at it from below, *above* him. Yet he was not wholly excluded from the space by reason of the lower opening. Of course they would not have said such were their conceptions, but such appears to me to be their latent origin, and from this we can draw conclusions as to their mental train of idea. May not the bounding arch represent a circular heaven? where was it in the temples of the ancient monarchies? The straight line preceded the circle. Man considered the plain before he looked up to the sky.

From these reflections naturally arises the question, looking at thought as seen from its visible exhibitions, what progress have we made? Are we not at exactly the stage of development as the paltry Republics of the Peloponnesian peninsula and the Hellenian mainland? It is admitted they are not excelled. Are we compelled to acknowledge a sort of "separate creation" for the Aryan, whose mental capacity is constant and equal through all ages, and only varies as a result of accumulative experience? I can't answer this off hand, but reply by another incidence in the world's history, viz., the complete development of the Jewish religion, on which Christ put the headstone, when he said Moses had insisted on an eye for eye, but He bid them offer the other cheek to the smiter. It is needless to repeat the change then in *one race*, but it did occur; and ordinances first issued as the commandments are now moral certainties.

There is one thing noteworthy, I think, in modern everyday writing, that is its crowdedness. The mind would ever seem to be crowding in with fresh ideas, edgeway as it were; a whole string of words will intervene between a proposition and a verb, a sentence three quarters told is interrupted by an explanation, beatitude, or otherwise even longer than the sentence itself, and so forth. Exactly so is the modern mind and modern architecture. I have seen somewhere that Herodotus, the early historian of Greece, ran on in his writings almost entirely without a full stop. Modern expression is always seeking too many at once. I think it was Hamilton who made it out that the human mind was capable of conceiving its distant ideas at one time; but we are improving on that, with a necessary consequence of confusion; if, however, we devote ourselves to one idea, is not the extra power of the modern mind made apparent by our achievements? If we only "kept it up" we must grow wiser.

VI. ON THE RECOGNITION OF NOISES.

ON an examination of the question with what part of the auditory organs we recognise noises, S. Exner, as far back as 1876, came to the conclusion that we perceive them with the cochlea and by means of the same tissues with which we hear sounds, that is by the Corti's fibres resting upon the basilar membrane of the cochlea and containing the terminal expansions of the auditory nerve. He founded this view upon Seebeck's experiment, in which a Savart's wheel from which so many of the teeth had been removed that it no longer gave out a sound, but merely a noise, still occasioned the feeling of an elevation of sound when it was made to revolve with greater velocity. He further caused two electric sparks to strike in succession, and on reducing the interval between them he recognised in the noise an elevation of tone.

Von Helmholtz, in the fourth edition of his "Treatise on the Perception of Sound" (Lehre von den Tonempfindungen), adopts Exner's view. He assumes that a single impact, if sufficiently strong, throws the entire elastic apparatus of the basilar membranes with all its organs into a strong initial movement, which then dies away in every single part in its peculiar period of vibration. Thus all the nerves of the cochlea are excited, and thereby the perception of the noise is effected without the decided prominence of any given sound. If the pressure of the wave of air upon the drum is prolonged the special vibrations of those parts of the basilar membrane which oscillate more rapidly than the duration of the pressure are enfeebled or suppressed, whilst those which vibrate more slowly are intensified. These parts of the basilar membrane give rise to the impression of a certain pitch of sound which is mixed with the noise. Still more distinctly is a certain pitch of sound manifested in a noise when the aërial pressure varies several times in succession from positive to negative. Thus we may have all the intermediate stages between noises without any definite pitch and sounds with a pitch. Professor von Helmholtz considers this a proof of Exner's theory that such noises are perceived with the same parts of the ear which serve for the distinction of sounds.

Setting out from these considerations, Ernest Brücke has recently published in the "Transactions of the Vienna

Academy," and in the "Naturforscher," a treatise on noises. He shows that if noises are heard with the same nerves as sounds of deep or of high pitch there must exist a subjective relation between noises and sounds of great wave lengths, and again respectively between noises and sounds of short wave lengths. This is supported in fact by daily experience. Music represents the discharge of cannon by the sounds of the drum, and the meaning is understood. The intensity of the detonation does not here come into play, since no one can confound a distant cannon shot with a pistol shot close at hand. On the contrary, a cannon shot, a rifle shot, the snapping of a percussion cap, and that of a small electric spark, form a series from a deep to a high pitch, so that noises also can be divided into low and high, according to the regions of the cochlea, which are principally excited in each case.

The tone of the tissues whose nerve-fibres are most strongly excited by a noise, and which determines the pitch of the explosive noise, must appear the more distinctly in its peculiarity the more distant the source of the noise. For whilst a cannon shot near at hand certainly excites all the fibres of the auditory nerves, a similar shot in the distance scarcely affects those nerves which are more feebly affected, so that a part only of the auditory nerves comes into play. Indeed, in the latter case the relation with a deep sound is much greater than in the former. With high explosive noises this difference is not so striking, because they are not loud enough to admit of a sufficient variation in the distance.

The better to understand what happens we must first reply to the question as to the simplicity of explosive noises, that is whether they consist of one wave or of a series of waves. Brücke, therefore, instituted experiments with different noises by means of a Koenig's apparatus for demonstrating the flame-images of the vowels—somewhat modified—and he observed that a good clap with the hands produced as a rule only one projection in the flame. The explosion of soap-bubbles filled with detonating-gas gave also generally only one projection. If a small organ-pipe (1050 vibrations) was sounded simultaneously to measure the length of the sound-waves the ignition of percussion caps gave one projection only, while without the organ-pipe several such were obtained. In the former case the feeble secondary impulses were overpowered by the stronger impulse of the pipe.

Brucke next examined explosive noises resembling the report of fire-arms, but more feeble and selected for this purpose lead pipes from which a stopper was driven by compressed air with a strong puff. This produced a series of projections of decreasing strength. But if the tubes were filled with loose cotton-wool so that the fluctuation of the air was checked, the stopper flew out almost without noise. If secondary fluctuations of the air occur in the lead tubes they must happen also on discharging a rifle or a cannon, and we can no longer deduce the deep tone in the report of the latter exclusively from the dimensions of the primary wave. We hear in the report of fire-arms a very brief sound, a sound too short to be recognised as such, and whose primary impulse, when sufficiently near, simultaneously excites all the cochlear fibres.

In a child's rattle, the noise of which is the higher the more the tongue is shortened, in the blows of a hammer, in stamping, &c., the noises must be judged in the same manner. The character is determined by the secondary vibrations of the parts which come in contact, and of those which are in such connection that they are simultaneously set in vibration. If they last long enough we have the production of a sound; if they are too short we have a noise the character of which depends on the period of the secondary vibrations.

If we examine experimentally what influence the length of a sound-wave exerts upon the auditory sensation which it produces, soap-bubbles filled with detonating gas are the most suitable. They must not exceed a certain size, otherwise all the fibres of the auditory nerves are in all probability affected together. The experiments showed that with a suitable mixture of air and hydrogen the large bubbles gave a duller, therefore a deeper, sound than the smaller ones, though the explosions showed only a single projection, and consisted therefore only of a single wave. The acoustic difference appears therefore with a single wave just as in the explosive noises which, besides the primary wave, produce also secondary vibrations. In both cases the character of the sound is determined by the especial excitement of a part of our auditory nerve fibres.

It is known that no deep tone can be produced by the movement of masses of air caused by single high explosive noises, even if the separate impulses of the air follow slowly upon each other. On this subject we can refer to former experiments with Savart's wheel. The reason must be that each single one of these noises does not set the lower tissues of the internal ear in such a vibration that its effect still exists when the second impulse follows, and therefore a repetition of each impulse cannot produce a summation of the excitement of the deeper-toned nerve-tissues. When, therefore, acute sounds follow upon each other in long intervals, we hear them singly as noises, because we hear them with parts of the internal ear which are tuned so high that they die away in a shorter time than the interval between the single noises. When this is not completely the case, or when the perceptions of the single impulses melt into each other, we hear a chirping, or, if the impulse is stronger, a rattling or a creaking.

Brücke corroborates this view by a series of experiments, with Savart's wheel, and with children's rattles: he shows that, for the experiments to be clear, every secondary vibration in any part of the apparatus must be eliminated. If this is not the case we obtain deep tones. When the secondary vibrations are checked as far as possible, a slow repetition of the impulse produces merely noises, but a rapid repetition gives distinct tones. Brücke obtains the same result with telephones, which produced noises if the electric impulses were slow, but tones if they were very rapid.

In his researches Brücke arrives at the conclusion that we have no need to assume the existence of distinct nerves for the perception of noises. According to the consideration advanced by Prof. von Helmholtz concerning the cochlea, we suppose that tones are produced when certain groups of the cochlear fibres undergo prolonged excitement, and that the tones are the purer the more equable the excitement, and the less rapidly they change in intensity. We suppose, further, that noises are produced when the same nerves are excited only for a very short time, or when the excitements pass in irregular and rapid succession from one group of nerves to another, or when they affect so many nerve-fibres simultaneously or in rapid succession, and in such alternation that it is not possible to hear out of the whole impression a tone of definite pitch.

In the view that the same nerves perceive noises if excited for a short time only is included the supposition that there is no fixed limit between tone (or sound) and noise. Between the sound which comes from striking a bell and the noise heard on striking a sheet of pasteboard there is a continuous series in which the vibration dies away so rapidly that no sound is heard. Even then the noise is of different quality according as—chiefly or exclusively—the higher or the lower elements of the organ of hearing are excited. The limit varies so much in different men that one perceives only a noise, whilst another hears not merely a sound, but can indicate its place in the musical scale. (And those men for whom noise and sound are identical ?)

We have also seen, in a series of explosive noises, that they approximate to quickly fading tones by means of the secondary vibrations of the air, and that, in accordance with the period of these vibrations, they are adapted to excite certain groups of nerve-fibres more strongly than others. For the secondary vibrations are by no means unimportant for the acoustic effect. As far as these groups of nerve-fibres are concerned, they add their effect to that of the primary wave.

These explosive noises possess also the attributes of height and depth, and, as we found the same qualitative difference also in single waves of different times of undulation in which no secondary vibrations have been demonstrated, we concluded that, as theory demands, even the single wave may affect the different fibres of the auditory nerve unequally, according to its period of vibration.

The shrill shriek of a steam-whistle, even when so near that we shrink back from the painful impulse, does not convey to us the joint impression of a deep noise, not even at the beginning, because the single impulse does not agitate the more deeply-toned parts of the auditory organ in so far as to cause a sound-perception.

The case is the same when two short steel cylinders are clashed together close by our ears, whilst the shot of a heavy cannon, miles away, which leaves the high-toned elements of our organ of hearing at perfect rest, occasions the perception of a deep noise. Whether the secondary vibrations (which by their period determine the groups of fibres to be excited) come into play or not, they can strengthen the effect of the former, but they cannot annul the action of the first impulse upon the other fibres if it has already set in.

For the case in which the impulses lie too far apart from each other to occasion a sound, it is unimportant whether they are single or if they die away with a few vibrations determined by the period of the fibre-groups which are excited. The quality of the noise depends only on the wave-lengths as long as the noises are heard singly, and when the impulses approximate and begin to melt into each other the rapid change in the strength of the excitement produces a creaking, and not, in the first place, the sound which ought to be produced in accordance with the period in which the impulses succeed each other.

There remain now, besides the momentary noises, explosions, and blows, the more continuous noises, rustling, murmuring, &c., and we must ask if they necessitate the assumption of special nerves?

In the roaring of the sea and the rustling of the wind among trees there occur very many small explosive noises and blows. We can sometimes hear them separately when we stand quite close to a tree through whose leaves the wind is passing. Along with these small blows there are in rustling also sounds of friction. These, in respect to the sound-waves, seem to bear the same relation as do the small irregular waves of a brook flowing among stones to the waves which arise on the surface of a sheet of water. According to our former observations it does not seem necessary to assume special nerves for the perceptions thus called forth.

Hissing is principally distinguished from rustling by the single noises being of a higher pitch and following more closely upon each other. Breathing and blowing represent the faintest irregular motions of the air perceptible by our hearing, and are also occasioned by friction.

None of these sensations compel us to assume separate nerves for their perception after we have once recognised that we perceive momentary noises, explosions, and blows, by transient excitement of a larger or smaller part of our sound-nerves.

In order to explain the manifold character of these sensations, we have a sufficient basis in the varying wave-lengths and amplitudes of the single impulses; also in their greater or less irregularity, in their quicker or slower succession, in their configuration, and, lastly, in the secondary waves which the first impulse produces by resonance, *e.g.*, on blowing into an empty bottle held before the mouth.

Still, on the other hand, the question arises whether, although we hear noises with our sound-hearing nerves, there may not be also nerves with which we hear noises but not sounds. These would have to be nerves which, on account of the peculiarity of their terminals, are not in connection with any sympathetic tissue, and have not the power of summing up impulses. Nerves exist to which this part might be ascribed, but there are physiological difficulties which, according to Brücke, militate against this supposition.

VII. THE MEXICAN AXOLOTL AND ITS SUSCEPTIBILITY TO TRANSFORMATIONS.

THE prolonged researches of Miss Marie Von Chauvin on the biological relations of the Amphibians have led to most interesting results concerning the transformability of the Mexican axolotl. The observations published by this lady ten years ago proved that under certain conditions, and by certain treatment, it is possible to convert the aquatic axolotl, breathing by means of gills, into the terrestrial *Amblystoma*, which breathes by means of lungs. Individual differences, however, came to light which demanded further enquiry. This has accordingly been carried out, and Miss von Chauvin now lays her conclusions before the public in the "Zeitschrift für Wissenschaftliche Zoologie."

It was soon found that younger specimens could be more easily transformed than older ones, but even among individuals of the same age great differences came to light, depending upon the manner of treatment. Thus axolotls can be more readily converted into Amblystomas if they are kept in water containing little air, and are thus compelled to come more frequently to the surface and to breathe with their lungs. Others, kept in richly aërated water, obtained a sufficiency of air through their gills, and were in consequence less readily converted. It appeared, further, that it is merely requisite to apply any external compulsion towards transformation up to a certain grade of development, and that when this has been reached the animals arrive at the higher form without any further interference.

The point of time when the axolotl has arrived so far in its metamorphosis as to have totally lost the power of living in water does not coincide with the absorption of the gills. On the contrary, the most recent observations prove that the power of the axolotl to live in water may under certain circumstances be retained for a long time in individuals which have become completely adapted to a terrestrial life, and only disappears after the first moulting. Various experiments with axolotls which had passed through this stage proved indubitably that a return to their former life had become impossible; they completed their metamorphosis even though all possible means were taken for its prevention. On the other hand, axolotls which had lived for months in damp moss, and had breathed with their lungs but had not changed their skins, felt completely at home as soon as they were returned to the water.

This surprising fact induced Miss von Chauvin to institute further experiments on the adaptive power of the axolotl, and in particular to attempt, by suitable treatment, a repeated transformation of these creatures, from the lower to the higher stage, and thence back again to the lower. This interesting experiment has, in fact, been carried out with a successful result.

Without entering upon an account of the means and the precautions used, or a description of the various stages of transformation, we pass at once to the results.

An axolotl lived altogether for three and a half years. The first fifteen months it spent naturally, and without any interference, in the water; its development was then artificially accelerated, and in twelve days it was transformed into a lung-breathing animal, It then lived on the land for fifteen and a half months; it was next, during the lapse of six days, brought back to the water, where it spent three and a half months. In the space of eleven days it was again so modified that it could once more live on the land, where it remained for rather more than six months, up to its death.

The power of adaptation to a change of medium was so distinctly marked in this animal, and was maintained for such a length of time, that Miss von Chauvin instituted a further experiment with axolotls with the object of interrupting at pleasure the metamorphosis of these creatures, and suspending it for years, and subsequently testing their adaptability. For this purpose served five axolotls, each about six and a half months old, in which the development of the lungs was easily so far accelerated that they could live on the land. At this stage the further metamorphosis was suspended by a low temperature and by being placed during the night in water. Nevertheless in one specimen there occurred quite unexpectedly, after the lapse of fourteen months and twenty-two days, the first moulting, followed by the further conversion into the *Amblystoma* form. The four others were kept, however, for three years and two months in the state of suspended metamorphosis. After the expiry of this time the attempt was made to convert two of them back into axolotls, whilst two others were to pass on fully into the *Amblystoma* stage. The result of this experiment was affirmative. The first two specimens reverted to axolotls; of the two latter one died, whilst the other became a perfect *Amblystoma.*

The three experimental subjects whose metamorphosis was arrested on November 8, 1879, were in good health in October, 1884, in spite of the most arbitrary interference with their natural course of development. The *Amblystoma* was indeed smaller than those which had been transformed previously, but it was, nevertheless, very active and greedy, and quite conveyed the impression of a healthy, well-developed animal. In the two axolotls also the arrest of the metamorphosis remained without injurious consequences. They are well developed and feel quite at home in their element. They can be distinguished from normal axolotls merely by a somewhat smaller size, and by a less luxuriant development of the external gills.

The results of these experiments show how exceedingly great is the influence of the surrounding medium upon the organism of animals. Of the most important agents, air, water, and heat, the last possesses indubitably the greatest power over the nature of the animal, and next after it comes the character of the medium in which the animal is compelled to live. The external conditions of life can transform the nature of an animal either by a sudden metamorphosis or by protracted action. But in opposition to all these external agencies there stands a powerful influence seated within the animal and acquired by inheritance which can, indeed, be modified to a certain degree but never entirely suppressed. This circumstance explains both the many individual fluctuations in the results upon perfectly identical treatment and the want of success of so many experiments.

Miss von Chauvin points out that the cases of "neotenism" (persistence of embryonal forms) recently observed among the Urodela find at least a partial explanation in the artificial transformations of the axolotl as here described. For it has been shown that the tendency to continued development can be suppressed by suitable influences, and such influences may make their appearances naturally and involve a persistence of the larval condition.

The importance of this series of investigations on the primitive transit of the vertebrates from the water to the land has been already pointed out. It must not be forgotten that the remarkable tenacity of life of the amphibians is a capital element, both in such natural transit and in the successful result of the experiments described. With insects the case is very different : their metamorphosis has, in certain cases, been suspended, both naturally and experimentally. But all attempts which we have made to induce the reversion of an insect to a larval condition have so far miscarried.

VIII. SILK AND ITS SECRETORS.

We see a spider spinning its net or a caterpillar lowering itself by a thread from the branch of a tree. But little do we think how many unsolved questions hang suspended on the silken lines. True, we know something about silk; our microscopists teach us that the thread of the silk-worm consists of two solid poreless rods like metallic wires laid side by side and cemented together; whilst the spider's line is composed of many such parallel strands, in some cases over a thousand, though each far more minute than the single line of a caterpillar. Our chemists have analysed this strange secretion and find that it consists of an outer, less compact portion, known in the trade as "gum," whilst within lies the true silk, named fibrione or sericine. Both these parts are composed of oxygen, hydrogen, carbon, and nitrogen, but the gum is less compact than the sericine, and can consequently be removed by a careful application of soap and water.

Last, though assuredly not least, our rogues have made the question of "weighting" or "loading" silk a matter of anxious study and of year-long experimentation, and are now prepared to convert one pound of silk into four or five pounds of something devoid of all the properties which render silk valuable, but which at any rate can be sold as silk.

But all this knowledge takes us but a very little way. Silk, it seems, is a compound of the so-called four organic elements. Its thread has therefore been likened to a thread which we might draw out of a solution of gelatine. But there are some capital differences. All the other nitrogenous portions of the organic system, liquid or solid, if exposed to the air in thin layers, pass very readily into putrefaction and decomposition. Not so silk. We may chop up rags or threads of silk and strew them on the fields or dig them into the soil. They may be exposed to heat and to frost, to sunshine and showers, to dew and wind. But in no reasonable time will they decay and return to the earth. Thence, unlike shoddy, hair, horn-shavings, all very similar to it in composition, save in one point only, silk, however plentiful, is of no value as plant-food. If a farmer were offered five tons of pure silk at ten shillings per ton he would be foolish if he accepted the offer and spread it on his fields.

We said that "in one point only" silk differs chemically from wool, &c., and that one point is very interesting. It contains, like gelatine, no sulphur. But between gelatine and silk the difference is wide. Gelatine dissolves in hot water and softens even in damp air. Silk, as we have just seen, is not acted upon by water. It exists, indeed, in solution in the secretory reservoirs of the spider, the silkworm, and other creatures. But when once it has been emitted and has dried and hardened, which it quickly does, it shows no disposition to resume a liquid state.

As regards the successive steps of the process by which silk is elaborated from the fluids of certain animals, and, of course, ultimately from their food, there is a sad lack of precise knowledge. One point is certain, that the diet of the silk-spinner has no direct influence upon the composition of the product. We find it yielded, though in varying quantities, by creatures feeding upon every kind of matter which is eatable at all,—upon the juices of living animals, the remains of dead ones, upon wood, leaves, fruits, and the pollen of plants. But all, we believe, eat heartily. The elaboration of a stock of highly nitrogenous matter over and above what is required for growth, for maintenance, and for the reproduction of the species, necessitates an abundance of nutriment.

We come now to the question what animals are silk-secretors, and we may be surprised to find that perhaps half the existing species of animals secrete silk, though in very varying quantities. It may probably be said that all insects which pass through a metamorphosis, that is such as on issuing from the egg are unlike their parents and have to pass through the successive states of a larva and a pupa, will be found to possess glands and reservoirs for the production and storage of this secretion. This would include all the Lepidoptera, probably all the Hymenoptera, a majority of the Diptera and Coleoptera, and some Neuroptera. The Orthoptera, Homoptera, and Heteroptera, which are hatched in forms closely resembling those of the perfect insects, save that the wings are generally absent, do not appear to secrete silk. It will be seen at once that among such a vast multitude of species not all can have been examined for the possession of silk-glands, and the rules we lay down must be regarded as merely tentative.

It is interesting to note that in the genus—so-called—to which the most ancient insects hitherto discovered belong, *i.e.*, the Orthoptera, the locust and grasshopper tribe, the power of secreting silk is not known to exist. Hence we may not unfairly infer that the secretion of silk is a function which has gradually been evolved since the first appearance of insects upon the earth. We find also that silk-spinning reaches its maximum development among the Lepidoptera, which are generally recognised as the most modern group. We say its maximum because there is not one butterfly or moth known which does not spin to a greater or less extent, whilst the silk-worm and its near allies produce silk in a greater proportion to their own weight than does any other animal.

All the species already noticed, broadly speaking, secrete silk in their larval state only, though indeed it is said that two insects are capable of spinning also when mature. Further observation is here wanting.

But among another Arthropod group, the spiders, the case is very different. Here a metamorphosis does not exist at all, and silk is of course secreted, if at all, by the mature animal.

However, the power of spinning is here less universal than in certain insect genera. Not merely the scorpions and other outlying groups, but many true spiders do not construct webs. Among those which do spin there is a wide range in the quantity of material at the creature's disposal and in the completeness of the work. Yet a certain writer has professed an inability to recognise here the workings of evolution. This is strange, if we reflect that amongst spiders we can trace successive stages, from the single thread used by some roving species to secure themselves against a fall when leaping upon their prey, from the few straggling threads laid upon the very surface of a wall or a tree-trunk, in which a creeping insect may entangle its feet, the shelf-like horizontal webs of the Tegenaria, which are soon clogged and rendered conspicuous by dust settling upon them, to the geometrical net of the Epeira extended in a vertical position between two trees, and which, in some lights, approaching insects seem unable to see. Surely, we repeat, we have here a series of phenomena not opposed to, but in harmony with, the main principles of evolution.

An interesting fact is that the silk-organs in the spider and in the insect, though subserving the same purpose, cannot be pronounced as respectively homologous. The caterpillar and all other spinning insects give out their thread from two organs situate on the upper lip, while the spinnerets of the spider are placed at the posterior extremity of the body and are consequently no modification of the parts of the mouth.

But silk-spinning extends into the world of waters. The Pinna and several mussels have a silk-gland and attach their shells to stones, &c., by a number of threads. It is needless to say that in this case the secreting and spinning apparatus is essentially different from that which we meet with in insects and spiders.

But having traced the production and use of silk so far there comes, perhaps, the hardest question of all: Why does it extend no further? Why do we find no vertebrate animals capable of spinning? It would be too hazardous to say that such a power, if it existed, would be of no use to such animals. If we run over in our minds the various purposes to which silk is applied by the Arthropods, we must admit that, if certain mammals, birds, or reptiles could spin, it would often give them a certain advantage in the struggle for existence. Suppose that a bird or beast of prey could construct a web between trees or in thickets, would not its prospectts of securing a fair supply of booty be very distinctly increased? Suppose that a bird when building its nest had the power of tieing its materials together and mooring them to the branches of trees with silk cords, would not its home be more secure? There is however, a reason to the contrary; a net large and strong enough to support, say, an animal of the size and weight of a fox or of a wild cat and in addition the hares, rabbits, birds, &c., upon which these destroyers prey, would have to be very strong, and would require a very large quantity of silk for its construction. Now, as we have seen, so highly nitrogenous a secretion as silk can only be elaborated at the outlay of an excessive quantity of food. It may well be, therefore, that the process would, figuratively speaking, not prove remunerative. In other words, the additional quantity of food captured by the aid of the net might not compensate for the additional quantity expended in the secretion of the silk.

Or, again, it may be that in the vertebrates the power of secreting varied products, colouring-matters, odours, poisons, and also silk is relatively feebler than among the Arthropods.

IX. ON THE SPONTANEOUSLY REVERSIBLE SPECTRAL RAYS, AND ON THE ANALOGY BETWEEN THEIR LAWS OF DISTRIBUTION AND INTENSITY, WITH THOSE OF THE RAYS OF HYDROGEN.

M. A. CORNU, in studying the spectroscopic reactions of metals, has come upon some most interesting results, which he has recently laid before the French Academy of Sciences.

The progress of spectroscopic research, and the wonderful extension of its applications, have led up to one of the most beautiful problems ever presented to the experimentalist and the generaliser. If we have given to us the chemical composition of a vapour raised to incandescence under definite conditions, the question is to foresee the distribution of the spectrum, of the radiations emitted and their relative intensity.

Though the attention of observers has often been called to this problem, its solution is by no means very near at hand. M. Cornu, therefore, proposes, after having briefly sketched the points where previous investigations have broken down, to point out an order of phenomena which seem to open out a novel track.

The starting point for all researches of this kind is the following observation:—When we examine the luminous spectra of incandescent vapours we often distinguish groups of rays which repeat themselves with a periodicity more or less regular. These repetitions are still more striking if we extend the scope of our observations up to the extreme limit of the ultra violet spectrum.

The analogy between these periodic groups and the harmonics of sonorous bodies presents itself at once to the mind. The notion is so much the more captivating because the positions of these groups, if considered either on the scale of wave-lengths, or on that of the numbers of vibrations, seem to coincide with the successive terms of the series of whole numbers. It is no wonder, therefore, that so many spectroscopists have yielded to the temptation and have sought to arrange the rays of one and the same spectrum according to a harmonic series.

What a palace in cloudland would G. H. von Schubert and Heinrich Steffens have built up from these analogies had they been known half a century ago!

Unfortunately the simplicity of these numerical relations always vanishes if we substitute for the contemplation of the spectral images a precise numerical determination of the wave lengths. The path of speculation therefore seems in that direction as if brought to an abrupt close.

This want of success, however, should not discourage observers, though the hope of finding a simple law like that of musical harmonics springs from a preconceived idea which should at once be swept aside. This law of whole numbers applies only to a very special form of sonorous bodies, the type of which is a cylindrical column of very great length as compared with its section. If the form of a vibrating body deviates from this special type the relation between the numbers of the vibrations of the successive notes becomes very complex.

This simple remark is sufficient to show that it would be childish to seek for a general law in a relation as simple as that of the harmonics of musical instruments. This would be to invest the structure of incandescent molecules with a mechanical constitution, which neither chemical nor physical phenomena seem to justify. Less simple laws do not succeed better, and this need not surprise us. The foregoing considerations show that we might expect to find, in order to define the distribution of the spectral rays, very complex functions depending on the chemical nature of the element, on the molecular structure of the vapour, and the conditions of vibratory excitement.

In fact what appears to have smitten with barrenness all efforts made towards the solution of the problem, is that observers have thought it necessary to impose upon themselves *a priori* the function destined to represent the succession of spectral rays. On the contrary, M. Cornu thinks it necessary to reject every preconceived idea as to the mathematical expression of the phenomenon, and to search experimentally if there do not exist special functions,—whether expressible or not by the ordinary analytical symbols,—which are capable of uniting under some common law these series whose regularity and periodicity are evidently not fortuitous.

Considered from this point of view the question assumes a novel phase. The immediate problem consists in searching, if there are not found in all spectra certain groups of rays presenting characters in common, independently of the chemical nature of the incandescent vapour.

With these ideas M. Cornu has for a long time pursued the study of the visible and of the ultra-violet spectra. He has succeeded in detecting a class of spectral rays possessing characters so distinct that they cannot be confounded with any others. These are the *spontaneously reversible* rays which M. Cornu described in the "Comptes Rendus" for 1871 (vol. lxxiii., p. 332), and the existence of which has been demonstrated in the spectra of most of the metallic vapours. The common disposition of their groupings, as will appear below, seems to define one of those experimental forms of function answering to the conditions above announced. The following are the facts:—

The spontaneously reversible rays are well known to physicists, and were observed for the first time by M. Fizeau, in the combustion of sodium. An incandescent vapour of small density and at a low temperature emits a certain radiation which corresponds in spectral observation to a certain brilliant but very narrow ray. If we increase progressively the temperature and the density of the vapour, the ray grows both in intensity and in width and becomes a true luminous band. Soon we see appearing upon this band a dark line in the place of the primitive fine ray, and finally the luminous band broadens in a manner somewhat indefinite, still presenting also the dark line, which also expands in a manner about proportional. Upon the luminous ground produced by the expansion of the band, the brilliant, non-reversible rays vanish completely.

These phenomena, observable in the visible spectrum with the majority of the volatile metals, and with the induction-spark, reach enormous proportions with the electric arc, especially in the ultra-violet region. There may be mentioned in particular the ray $\lambda = 228{\cdot}85$ of cadmium. This ray, extremely weak with the induction spark, expands in the arc so as to invade almost the entire photographic spectrum. As for the dark reversal band which occupies its centre, it comes to occupy more than half the interval between the rays 23 and 24 (Mascart's notation), which disappear almost entirely. We may further mention the ray $\lambda = 209$ of zinc; two of the components of the quadruple ray of magnesium $\lambda = 280$, as also certain fine groups in the spectra of aluminium and thallium.

Various observers, above all Messrs. Liveing and Dewar, have observed a great number of curious reversals in the most various circumstances. The most interesting, perhaps, are those of the hydrogen rays in the visible spectrum, and in the ultra-violet that of the ray $\lambda = 285$ of magnesium, which is easily obtained on burning the metal in the air. It may be added that the so-called *long rays*, defined somewhat arbitrarily by certain spectroscopists, often enter the class of the spontaneously reversible rays.

It is scarcely needful to point out that the ordinary laws of luminous absorption and of refrigeration suffice to explain all these phenomena. But if theory is able to predict the possibility of the reversal of a certain ray it tells us nothing concerning the property of certain radiations to present, under given conditions, spectral reversions to the exclusion of others.

What are, generally speaking, the conditions of temperature, of pressure, and of density the most favourable to the production of this singular emissive power? This, for the present, is difficult to say. We obtain the phenomena by the incandescence of metallic vapours in a space more or less limited, heated by the electric arc or by direct combustion. But it is evident that these conditions have to be determined with more precision, and that they are imperfectly fulfilled by the means used in the production of emission spectra.

(To be continued).

ANALYSES OF BOOKS.

The Winds: an Essay in Illustration of the Principles of Natural Philosophy. By W. LEIGHTON JORDAN, F.R.G.S. Third Edition. London: D. Bogue.

MR. JORDAN is generally looked upon as a heretic in Science, and as a "vera troublesome person." Like many such persons, he has a habit of looking upon familiar phenomena from a novel point of view, and of calling for reasons which our official scientists are not always ready or willing to produce.

The treatise before us forms the third and fourth chapters of a former work of the author's, entitled "The New Principles of Natural Philosophy." One of its objects, as stated in the Dedication, is to show the connection between the Cartesian vortices and the Newtonian laws of gravitation.

The author, in his first chapter, raises the question why the Trade Winds, sweeping along the Earth's surface towards the Equator, do not take their rise in the Arctic regions, but are confined within the Torrid zone, from which an opposite current —the Anti-Trades—sets out, though with less regularity, and passes through the Temperate zones towards the Poles. This feature has puzzled such authorities as Halley and Maury. Indeed the Anti-Trades are exactly the reverse of what the difference of temperature should produce. The author, to meet this difficulty, maintains that the main agency is the gravitation of the Sun and Moon, and indeed, to a less extent, of all extraterrestrial bodies in conjunction with the centrifugal force of the Earth's rotation. This rotation causes the winds to blow from an intermediate point, or rather from two intermediate points, one in each hemisphere towards the Poles and towards the Equator. The reason why the Trades are more constant than the Anti-Trades lies in the heating action of the Sun, which assists the former, but constantly tends to reverse the latter. The "lagging" of the Trade Winds, and of the Moon in its orbit, accords with, or is not at variance with, the idea of its being due to "the action of a revolving force acting from some point between the centre and the surface of the Earth, and with a force inversely as the cube of the distance from that point." The action of a similar force about the Sun must, the author holds, be the cause of the onward movement of the planets in their orbits around the Sun.

Astral gravitation, it is suggested, is transmuted into light by the friction of the rotation of the stars, whilst terrestrial gravitation is transmuted into heat by the friction of the Earth's rotation against those rays of light. "In this case the light emanating from the Sun is caused by the same conflicting action of solar gravitation which carries and guides the Earth in its orbit."

We may here remark that the experiments made for the reciprocal transformation of gravitation, and the so-called physical forces or modes of energy, have so far led to no decisive results.

In Part XIII. it is suggested that if the rotation of the Earth were more rapid, its action would carry everything lying loosely on the Earth first to the Equator and then upwards. If it be true that the Earth's rotation is being gradually retarded, the Earth may have passed through a phase similar to that of Saturn, and may once have had its belts. This chapter is accordingly headed "A Belt of Boulders." But is it in evidence that such belts exist on a parallel to the Equator to a greater extent than in other regions of the Earth's surface?

Mr. Jordan considers that the obliquity of the ecliptic to the Equator depends not on cosmical, but "on local terrestrial causes which determine the plane of rotation, and have frequently changed that plane." We doubt, however, very strongly, whether any such changes would account for the epochs of glaciation and for the genial climate of the earlier Miocene.

We have thus presented a brief, and we trust not unfair, view of the author's main ideas, for the demonstration of which we must refer to the work itself.

An Introduction to Practical Organic Analysis. By G. E. R. Ellis. London: Longmans, Green, and Co.

This is a very small book for so wide a subject as organic analysis. It will, however, be at once seen that the author gives instructions merely for the recognition or detection of certain organic bodies, and not for their quantitative determination. Thus what is perhaps too conventionally known as organic analysis, the determination of the four principal organic elements by combustion, is conspicuous by its absence. Numbers of organic compounds also—we may especially mention the colouring-matters—have not fallen within the author's plan. Still we must admit, with some surprise, that considering the very limited compass of the treatise the author has contrived to describe the characteristic behaviour of a very great number of substances.

The work is, we are told, primarily intended for the use of medical students, and hence we find a chapter devoted to examination for poisons. It is, of course, theoretically speaking, unchemical to classify bodies according to their behaviour with the living animal or vegetable body; but to the medical practitioner, the pharmacist, and the sanitarian this category is very useful. Among the poisons we find no mention of chromium, which is now used on a vast scale in the arts, and may consequently give rise to accidents.

The methods laid down for the recognition of the various substances may be considered as satisfactory.

The least acceptable feature of the book, in our opinion, is that it is written from the "examinational" point of view at present endemic in England.

Notes from the Physiological Laboratory of the University of Pennsylvania. Edited by N. A. Randolph, M.D., and S. G. Dixon. Philadelphia: J. B. Lippincott and Co.

We have here the records of original investigations undertaken chiefly from the point of view of the practical physician. These papers discuss in succession the fæces of starch-fed infants; the fæces of persons receiving inunctions of cod-liver oil; the distribution of gluten within the wheat-grain; the effects of the administration of turpeth mineral; a reaction common to peptone and the bile-salts; the behaviour of hydrobromic acid and of potassium iodide in the digestive tract; the digestion of raw and boiled milk; the nutritive value of branny foods; a metastatic heat-regulator; the behaviour of petrolatum in the digestive tract; the cutaneous absorption of nicotine; the dietetic factor in the treatment of angina pectoris; a painless escharotic; and the cutaneous absorption of salicylic acid.

The first of these papers, which we have had the pleasure of receiving and noticing in a separate form some time ago, proves that, contrary to the general opinion, many children under three months of age can digest starchy foods.

The second memoir demonstrates that, in a majority of persons, both infants and adults, cod-liver oil applied persistently to the skin makes its appearance in the excretions.

In the paper on wheat-grain the author questions the assumption that the gluten is found almost—if not quite exclusively—in the fourth layer of the grain, as according to Parkes, immediately below and adhering to the third or inner coat of the true bran, whilst the interior of the grain is made up exclusively of starch-granules.

This belief lies at the root of the so-called "bread-reform" movement, and hence, as Dr. Randolph puts it, "many most intelligent persons habitually rasp their digestive surfaces with branny food." The question is one of importance to the entire wheat-consuming portion of the human race, and the author has therefore done good service to the world by demonstrating the presence of gluten in notable quantity in the interior of the grain.

The fifth essay supplies evidence that Millon's reagent is useless as an isolated test, seeing that it reacts with two such distinct compounds as peptone and the bile-salts.

In the seventh paper Dr. Randolph shows that milk is more easily digestible when raw than after boiling; in the latter state it is less sensitive to rennet, but much more to acids, whether strong or dilute.

In the next memoir—a study of the nutritive value of branny foods—Dr. Randolph, after a prolonged course of experiments and observations, concludes that the carbohydrates of bran are digested by man to a slight degree only; that the nutritive salts of wheat are contained chiefly in the bran, and therefore, when bread is eaten to the exclusion of other foods, the kinds of bread which contain these elements are the more valuable. But when, as is usually the case, bread is used along with other foods which contain the inorganic nutritive elements, a white bread offers, weight for weight, more available food than does one containing bran. By far the major portion of the gluten of wheat exists in the central four-fifths of the grain, entirely independent of the cells of the fourth bran-layer (the so-called gluten-cells). Further, these last-named cells, even when thoroughly cooked, are little—if at all—affected by passage through the digestive tract of the healthy adult. In an ordinary mixed diet the retention of bran in flour is a false economy, as its presence so quickens peristaltic action as to prevent the complete digestion and absorption not only of the proteids contained in the branny food, but of other food-matters ingested at the same time. Still, as in the bran of wheat as ordinarily roughly removed, there is adherent a notable quantity of the true gluten of the endosperm, any process which in the production of wheaten flour should remove merely the three protective cortical layers of the grain would yield a flour at once cheaper and more nutritious than that ordinarily used. These results, it must be admitted, are of great practical moment, and seem to us to cut away the ground from under the feet of the bread-reformers.

The tenth memoir relates to a subject which has only recently arrived at practical importance. Most of our readers will be aware that the mineral fats, or more correctly hydrocarbons, have found their way into the hands of the Parisian pastry-cooks. That when introduced into the digestive organs they should not be assimilated might have been expected. But Dr. Randolph has demonstrated experimentally that this mineral fat is entirely rejected and is found unchanged in the faæs. Hence the conclusion is simply that these hydrocarbons are, as articles of food, quite useless. The author's experiments further go to prove that oily matters are absorbed, not by mechanical, but by physiological action.

The interest of the remaining sections of this book is purely professional.

Bulletin of the Philosophical Society of Washington. Vol. VII. Containing the Minutes of the Society and of the Mathematical Section for the year 1884. Published by the Co-operation of the Smithsonian Institution, Washington.

A GREAT part of this volume is taken up with the annual address of the President, Mr. James C. Welling, on "The Atomic Philosophy, Physical and Metaphysical." This very interesting and important discourse opens with a historical survey of the rise and progress of atomism. The speaker recognises the Atomic Philosophy of the Greeks as the most elaborate and ingenious which has come down to us from all antiquity. He admits that the Epicurean physics are "as much superior to the Aristotelian and the Stoical physics as the ethics of the Lyceum and the Porch are superior to the ethics of the Sty." Yet he at the same time contends, and with fullest justice, that in the whole system there is not an atom of scientific truth. "The whole speculation is a mirage caused by unequal refractions in the Greek intellect." If atoms exist they must needs be chemical conceptions, and the *rationale* of chemistry had not yet dawned on the horizon of the Greek intellect.

This naturally brings us to the much discussed subject of the incapacity of the Greek mind for Science. Mr. Welling criticises the explanation of the fact given by Dr. W. Whewell, who, as our readers will remember, argues that though the Greeks had in their possession an abundance of facts and were acute observers and critics, their ideas "were not distinct and appropriate to the facts." On this he remarks that it would hardly be possible to frame an explanation more pointless. The Greeks had very distinct ideas and their hypotheses were illusory, precisely because they were so "appropriate" to the surface facts of Greek observation. Quoting Professor Jewett, he tells us that "ancient logic was always mistaking the truth of the form for the truth of the matter." He asserts that: "The conscious incapacity of the Greeks for physical science was so great that we find the very best class of minds among them absolutely revolting at the very idea of such a science. Socrates, for instance, had no patience with it." Now, it seems to us that Mr. Welling somewhat misapprehends the character of the Socratic Apostasis. That he hated what we now call Science is indisputable. That his influence with that of his followers and imitators has mainly contributed to the exaltation of words and dreams and to the neglect of things which has so greatly impeded the advancement of science, and which is even yet defended by the "poor humanist," is equally true. But was he really one of the best class of Greek minds? Would Greek incapacity in Science have remained a conspicuous stumbling-block but for the ascendancy gained by him and by his school? To both these questions we think we may venture to reply in the negative.

To the remainder of this suggestive discourse we have to return on some future occasion.

At the General Meeting of the Society Mr. T. C. Russell read a paper on the glaciers of the high Sierra of California. He points out that the glaciers of the Sierra Nevada were not connected with a northern ice-sheet, but were of mere local origin and of the same type as the Swiss glaciers of the present day, although of far greater magnitude.

A paper read by Mr. C. V. Riley on "Recent Advances in Economic Entomology," contains some passages on which issue may be well joined. The author pleads for what is commonly, though not quite accurately, known as "applied science." He writes: the best results follow when the pure and the applied go hand in hand—when theory and practice are wedded together. But the most profound investigations are generally incapable of any direct application. Who, *e.g.*, can reduce to practice the results of Darwin, of Wallace, of Lyell, and of many, if not most, of their compeers? He says again, in the same spirit: Erstwhile the naturalist was honoured in proportion as he dealt with the dry bones of his science. Pedantry and taxonomy overshadowed biologic research. We may ask with not unjustifiable surprise, where are the pedantry and taxonomy in Gilbert White, in Waterton, in quaint old Rösel, in Swammerdam, and in Leuwenhoeck?

The fact is that in physics and chemistry discoveries often, and that rapidly, pass into or become intertwined with inventions. But in biology, palæontology, psychology, this is not the case. We find here, save incidentally and collaterally, nothing for which a patent may be taken out and a company got up.

Mr. Burnet discussed the question "why the eyes of (some) animals shine in the dark?" This is not due, as some suppose, to phosphorescence, but to light reflected from the bottom of the eye, which light is diffused on account of the hypermetropic condition prevalent in the lower animals. Human eyes, affected with hypermetropia, do not yield similar results, because the human pupil is too small, and because the bottom of the human eye has not so strongly reflecting a surface as that of most animals. A distinction was pointed outbetween fluorescent and phosphorescent light,—the former disappears as soon as the incident waves are cut off, while the latter does not.

Mr. G. K. Gilbert examines if the rivers of the northern hemisphere being by the rotation of the earth pressed against their right banks, and those of the southern hemisphere against their left banks, this pressure can appreciably modify the courses of rivers ?

At the meeting on May 10, 1884, the question " what is a glacier ? " was discussed in the form of a symposium. It was not forgotten that hard and fast lines of demarcation do not prevail in nature, but rather gradations of character.

At a meeting on May 24, Mr. H. H. Bates read a paper on the " Physical Basis of Phenomena." In summing up he declares that " It is time to get back to Baconian ground, and while using for its legitimate purposes the magnificent modern machinery in the field of abstract continuity,—extension, motion, duration,—not attempt to conjure with it as a source of objective revelation, which no mere machinery can be. A scaffold of *n* dimensions is as useless to the geometer as to the architect."

Mr. S. M. Burnett read a paper, entitled :—" Are there Separate Centres for Light-form and Colour Perception ? " He answers this question in the negative, maintaining that there is no white-light sensation which can be revolved into its constituent elements of colour sensation, and that the sense of form is an expression of the idea of extension as represented by the dimensions of the arc of the retina impressed.

Mr. Washington Matthews sent in a paper bearing the very curious title of " Natural Naturalists," and bringing to light a very curious fact. The author finds that the aborigines of America acquire and disseminate information about creatures which they do not use. " I have never failed," says he, " to get from an Indian a good and satisfactory name for any species of mammal, bird, or reptile inhabitating his country ; and I have found their knowledge of plants equally comprehensive. The Indians are in this respect, as a class, " incomparably superior to the average white man, or to the white man who has not made geology and botany a subject of study."

This evidence shows how much our powers of observation have been stunted by the exclusively, or at least mainly literary, character of our educational systems. From childhood our attention is fixed upon words, written or spoken, and except among specialists inobservance has followed.

Papers and Proceedings of the Royal Society of Tasmania for 1884.

We find here an account of the Ceylonese serpent eagle, *Spilornis spilogaster,* with a notice of the distribution of the genus *Spilornis,* a typical Indo-Malayan form which possibly crosses Wallace's line.

Judge Dobson made a timely protest against the wanton destruction of the magnificent tree-ferns of Mount Wellington. He proposes that the Mount Wellington reserve should be made a people's park, with appropriate penalties for the removal of trees and ferns.

Col. Legge, in presenting to the Society a specimen of the brown fish owl, *Ketupa Ceylonensis,* remarked that no large owls were found in Australia except a variety of the barn owl known in England. In Tasmania no species of kite is found, though they are common in Victoria, South Australia, and Western Australia.

According to a paper read by Mr. R. M. Johnston, F.L.S., there is a marked rise and fall in the death-rate both in Europe and Australia, the periodicity of which closely corresponds with the maxima and minima of sun-spots and with the movements of Jupiter in his orbit from aphelion to perihelion.

According to a copy of the "Australian Shipping News" laid on the table by Mr. M. C. Brown, a whale captured in Behring's Straits, in June, 1883, was found, when cut up, to have embedded in his blubber a harpoon with the words "Henty L., 1838" branded upon it. The Henty's, an old colonial family, had in 1838 a whaling establishment at Portland Bay, Victoria.

Mr. R. Henry described the damage to submarine cables in the Eastern seas, inflicted by a species of *Teredo,* which bores through the gutta percha.

In a paper on the Tertiary Flora of Australia, communicated by Baron von Ettingshausen, the opinion is enunciated that the whole existing flora of the world can, in its development, be traced to an universal original flora of by-gone geological ages.

Mr. R. M. Johnston, F.L.S., read a paper on the discovery of two ferns new to Tasmania. These are *Hymenophyllum marginatum,* hitherto only known in New South Wales. and *H. malingii,* supposed to be peculiar to New Zealand. Of the 201 species of ferns found in Australia and Tasmania, only 53 are found in the latter island, and only one of them is peculiar.

The Neanderthal Skull on Evolution. In an Address supposed to be delivered A.D. 2085. By the Rev. BOURCHIER WREY SAVILLE, M.A. London: Longmans and Co.

THIS is, in very truth, a singular production. The common arguments against Evolution, as they are accepted and retailed by men who are not naturalists, are here reproduced in the form of an address supposed to be delivered in St. James's Hall, Piccadilly, two centuries hence. What opinions may be held in the year A.D. 2085 and what may be uttered in St. James's Hall, if that noted locality has not in the meantime been improved off the face of the earth by the dynamitards, we cannot venture to predict. But in view of the fact that the evidence in favour of Evolution is becoming stronger from year to year, it is not rash to assume that before two more centuries have passed, the doctrine of mechanical creation will be, as it is fast becoming, a mere matter of history. We shall return to it when we return to pre-Daltonian chemistry and pre-Copernican astronomy.

Mr. Saville speaks of Charles Darwin with great courtesy, though decidedly underrating his intellectual powers and the value and significance of his results. But whilst repeatedly vindicating our great naturalist from the charge of Atheism, he does not hesitate to quote from a Mr. Noel the following passage:—"The positive evidence of Scripture is against Evolution, whilst on the other side we have purely and simply a theory, whose whole strength depends on the foregone conclusion, that miracles must, if possible, be exterminated." This Mr. Noel must have his interesting side!

In the very preface we find (xx.) a glaring mis-statement. The author states that there are upwards of 20,000 species of animals in creation (had he said 200,000 he would have been still below the truth), and all experience shows that in every instance when crossing species has been attempted, in place of there being any improvement, or the transmutation of one species into another, *sterility* has been the invariable result." This is simply not the fact. We know that the domestic cattle and the bison of North America (familiarly called buffaloes) belong, not merely to distinct species, but to distinct genera. Yet they are capable of fruitful intercourse and the progeny is *not* sterile, as it has been conclusively proved on the large scale. Were it not that the hybrids, like the bison, yield less milk than the common cow and are more given to stray, they would have become common farm-animals. (See Mr. J. A. Allen's "History of the American Bison.")

Among birds cases of fruitful hybrids, if not more common, have been more frequently observed. If Mr. Saville had taken the trouble to refer to Mr. Seebohm's interesting work, "Siberia in Asia," he would have learned that inter-breeding between the hoodie and carrion crow is common. This ornithologist found such hybrid birds mated together and producing eggs and young. In Germany and Austria the male capercailzie is often found mated with the black hen *(T. Tetrix)*, and the pure breed of the latter is, according to Semper, being, in some districts, superseded by the hybrids.

If sterility is the necessary condition of hybrid animals the same law should necessarily extend to plants. Yet here, according to many observers, including the eminent botanist Prof. Meehan, fertility is the rule and sterility the exception. If we return for a moment to animals we might well ask among how many species has crossing been fairly attempted? Nor must we forget that many animals in captivity, even if matched with their own species, either prove barren or, at least, do not produce viable young.

On the very next stage the author reproduces the threadbare objection that "the supporters of the theory have never succeeded in observing a single instance, in all the millions of years invented (!) in its support, of one species of animal life turning into another." Now, *ex hypothesi*, one species turns into another, not rapidly and as in a transformation scene, but in successive generations, each being born being a shade different from its progenitors. Hence to observe such a change is excluded by the very terms of the question. Does Mr. Saville forget Mr. Herbert Spencer's apologue of the ephemeron which had never witnessed the change of a child into a man? Further, the supporters of the theory have not for millions or even thousands of years had the opportunity of observing all species of animals, or even one species, with sufficient minuteness. Nor must we forget that within the historical ages no one has seen one breed of animal pass into another. Nor does the author ask himself or his readers whether anyone has ever seen a new species of animal make its appearance by mechanical creation.

On the faith of Dr. Elam the author rejects Organic Evolution as "an unverified theoretic conception." Now all working naturalists know that the theory is constantly receiving verifications,—that it accounts for and harmonizes facts which previously were a mere desultory mass. In the same preface the author asserts that he has shown by quoting the *ipsissima verba* that all the scientific celebrities of the 19th century have rejected the Evolution theory, either positively or inferentially.

Now, Mr. Saville has forgotten that a scientific celebrity, who is not a special student of biology, can have on such a question not the slightest claim to authority. Hence, with all due respect to their merits in other directions, we must bow Prof. Max Müller, Clerk Maxwell, Phillips, Main, Challis, Stokes, Tait, &c., out of court. We must remember that Prof. Virchow, though probably the first histrologist in the world, has not studied biology from that point of view requisite for judging of the origin of species, and that he has recently protested against being set down as an anti-Darwinist; St. George Mivart, though not a Darwinian, is a decided Evolutionist; that the intellect of Agassiz is, on American authorities, supposed to have been in its decay before his rejection of Darwinism, and that Sir R. Owen gives on the question of Evolution a very uncertain sound.

To find Thomas Carlyle, the essentially unscientific or, rather, anti-scientific word-monger, classed among English scientists may make us blush. As to Frank Buckland, though a good observer of facts, he was nothing more. Among "foreign scientists" hostile to Evolution we find mention of Humboldt. Now, Humboldt detested Cuvier, and as far as we can judge was favourable to Evolution.

But if Mr. Saville thinks that the question is to be decided by authority, why does he make no mention of the long and brilliant series of *savants*, Continental, British, and American, who accept Evolution,—men specially qualified as naturalists? Candour certainly dictates that the reader should hear of these men also. In fact, there is in our day scarcely a zoologist or botanist of mark who is not working on Evolutionist lines. It is greatly to be lamented that the subject has not been left to these men, who if they find the theory coming in collision with facts will not keep silent. The intrusion of novelists, divines, lawyers, newspaper writers, &c., merely "darkens counsel."

Bacillary Phthisis of the Lungs. By GERMAIN SEE. Translated and Edited for English Practitioners by W. H. WEDDELL, M.R.C.S., Eng. London: Kegan Paul, Trench, and Co.

THIS work, as may appear from its very title, is distinctly professional in its objects. The author begins with the history and tradition of his subject. Here, as it seems to us, he is guilty of an act of injustice in omitting all mention of Dr. William Thompson, of Melbourne, who most distinctly anticipated Dr. Koch in tracing phthisis to the action of a microbion. There are no grounds indeed for supposing that Dr. Koch was aware of the researches of his predecessor; he made his discovery subsequently, but independently. It is curious to note that whilst Koch has received for his discovery honours and more tangible rewards, Thompson has incurred no little obloquy; and for showing that the Australian climate is no specific for pulmonary consumption he has undergone something very like boycotting.

The author, after his historical sketch and certain definitions, proceeds to the biological study of micro-organisms, firstly in general, and secondly the biology of pathogenic or specific microphytes. He then treats of microphytic maladies, of the forms and culture of the tubercular bacillus and of tubercle in its forms, evolution, and nature. The various causes and conditions of tubercular disease are next taken into consideration.

Here we find an account of the atmospheric causes producing phthisis. There are some interesting facts given concerning the occurrence of micro-organisms in general. They are described as having their maximum in summer and their minimum in spring, though great and prolonged heat diminishes the numbers. The quantity of organisms in the air increases directly as the atmospheric pressure. Dry weather favours them, and so does ozone in small quantities. Above the level of 2000 metres none have been found. The experimental respiration of air, charged with pulverised materials from cavernous expectoration, has invariably conveyed the disease.

Among the conditions favourable to phthisis ranks town-life, especially in over-crowded barracks, shops (*e.g.*, those of the monopolist drapers), schools, prisons, &c. Climate is pronounced to have but a secondary influence. Philadelphia, Marseille, Paris, have a greater proportion of deaths from phthisis than has London.

In the clinical portion of the work phthisis is divided into four categories : the latent, the distinct, the masked, and the doubtful or pseudophthisis.

The chapter on hygiene is very important. It is urged that as far as inoculability is concerned, phthisis presents a perfect analogy with small-pox or syphilis. The contagion is effected in two ways : by the digestive tract through the agency of food, and by the respiratory organs. Both the flesh and the milk of suspected animals should be avoided. Phthisis is very common among oxen and cows, less so among pigs and poultry, but it does not attack sheep. Hence, from this point of view, mutton is the safest animal food. The use of meat raw in the centre of the joint is dangerous. A temperature of 140°, 150° F., in no way destroys its virulent properties. There is no safety unless every portion of the meat has been raised to 212° F. The same temperature deprives the milk of infected animals of its dangerous properties.

Atmospheric contagion is effected by air vitiated by phthisical patients, especially by the dust from articles upon which such patients have expectorated. The great cause of phthisis is therefore urban life : the immigration from the open country into the cities. This is an evil which in innumerable ways is degrading the human race, and which, though the physician can merely point out, ought to be attacked from every possible point. Any and everything which tends to promote this evil should be sacrificed without hesitation.

The author states that the blood of a young child is for a certain time refractory to the microbion. He asks can this stage of resistance not be prolonged? Cannot, so to speak, the soil be sterilised as against this parasite? Among the known and available resources he enumerates gymnastic exercises, such especially as develop respiratory power and capacity, hydropathic means, and lastly, food which must be so regulated that there is a predominance of fatty matter, any excess of potash salts being especially to be avoided. He argues, indeed, that the reason why the herbivora are more subject to tuberculosis than the carnivora is the larger proportion of potash salts necessarily present in their systems.

The value of this work to the medical practitioner is indisputable. But to outsiders, if candidly read through, it may also be of service as opening their eyes to the nature and import of the problems which modern medicine is called upon to solve, and as to the methods which it must employ. If this is done, sneers at the germ-theory may, perhaps, become less frequent.

California State Mining Bureau. Fourth Annual Report of the State Mineralogist, for the year ending May 15, 1884. By H. G. HANKS, State Mineralogist. Sacramento: State Printing Office.

THE situation of the Mining Bureau leaves something to be desired. Though the library and museum are very valuable, they are in constant danger of fire. The museum is situate over a stable (!) whence emanate "disagreeable ammoniacal and hippuric odours," whilst the specimens are disturbed in their cases "by the jarring made by the hoisting of hay by tackles attached to the under side of the museum floor." It now contains 6000 specimens, and fresh accessories come in faster than they can be arranged.

The chemical apartment is in abeyance. It is remarked that since the discontinuance of laboratory work, and the discharge of the efficient chemist for want of funds, little chemical work has been attempted. A mining bureau without a well arranged laboratory and an efficient chemical staff seems to us quite a mistake.

The report before us is by no means exclusively confined to the mineral resources of the State. The hydrography, forests, scenery, and climate are also noticed. We find it stated that the coniferous forests alone cover some twenty million acres. That the climate is less extreme than in the central and eastern States. Tornadoes are wanting, and the deaths from sunstroke and lightning do not exceed a dozen. The advantages of California are certainly not under estimated by the writer or his authorities. Thus we find it asserted that "there can be little doubt but the bulk of the wines turned out in this State will, in the course of a few years, be superior to those produced in any other part of the world,"—a bold saying. It is admitted that the attempts at growing coffee, tea, and tobacco have not been successful. The first of the three is injured by frosts, whilst the leaf of the two latter is wanting in flavour. The American cranberry here mentioned is, we hope, an essentially different fruit from that of central and northern Europe, the flavour of which may be admirably imitated by adding to the sourest red currants a decoction of oak-bark. We are sorry to find that the cultivation of chicory is extending. It is to be regretted that whilst the coffee tree and the vine are decimated by parasites the chicory plant and the sugar-beet have comparatively escaped.

Letter of Mr. W. H. Pickering, entitled "An Attempt to Photograph the Corona." Reprinted from "Science," No. 113, April 3rd, 1885.

Copy of Reply addressed to the Editor of "Science." April 22nd, 1885.

In the former of these two letters Mr. Pickering states, that on occasion of a late partial solar eclipse, he attempted to repeat the experiments of Mr. Huggins on photographing the corona. He describes the arrangements adopted and the results obtained, and draws the following conclusions:—"The conclusions I should draw from my experiments are (1), that, though it is very easy to obtain a corona-like image, one may readily be deceived in such matters, and the same effect obtained by our atmosphere, without the aid of the solar-corona, combined with little defects in the gelatine film (this, I think, is conclusively shown by the extension of the pseudo-corona in front of the moon); (2) that chloride plates are more suitable than bromide for obtaining an atmospheric corona, just as Mr. Huggins has claimed that they are more suitable for taking a solar one; hence I think one must not rely too much on the ultra-violet region sensitiveness of the chloride plate for a separation of the two; lastly, though my experiments fail to corroborate Mr. Huggins's results, they do not, of course, show that his corona may not be solar, but merely indicate that under very favourable circumstances I could obtain no trace of it."

He adds that he has before him a print made from a negative by Dr. O. Lohse, in October, 1878, showing effects very similar to those obtained by himself (Mr. Pickering.) He further adds that Dr. Lohse considers that the halo is wholly atmospheric and not coronal.

In reply, Mr. Huggins points out that the false coronal effects which Mr. Pickering obtained are precisely those to be expected from his methods. Mr. Huggins expresses his suprise that Mr. Pickering should have mentioned his name in connection with experiments carried out in complete disregard to the conditions to which he had called attention as essential. He adds that whatever Dr. Lohse may possibly have stated privately his published statement admits of no such construction as that put upon it by Mr. Pickering.

Think! A Reply to Lord Bramwell's Plea for "Drink." By DAWSON BURNS, D.D. London: National Temperance Publication Depôt and Alliance Offices.

THIS publication scarcely ranks among the subjects which we are in the habit of discussing. We may fully concede that alcoholic fluids are not necessaries of life. We may further consider it an error and a chemical sin to use any substance containing a notable proportion of organic nitrogen for any purpose whatever in which such organic nitrogen is not essential, and we may thus pass an unfavourable judgment upon the brewer and the distiller. We may even, going beyond "Teetotaller," express our conviction that in a cold damp climate like ours a man whose food is rationally selected will, under ordinary circumstances, need no liquids of any kind. But at the dictum here quoted from the late Duke of Albany, "Drink—the only terrible enemy England has to fear," we can only smile and think that if this young man had had time to observe more he might have become conscious of the existence of not a few other terrible enemies from which, as a nation, we have much to fear.

Nor can we believe, as do many that the legislative abolition of the drink traffic would land us in Utopia. We believe, with Mr. McElroy ("Popular Science Monthly"), that "with very few exceptions, every man who goes to perdition by the Alcohol route would reach that destination by some other highway if the alcohol line were not running." But on this subject we may refer our readers to the article "Vice as an Eliminative Agent," ("Journal of Science," 1883, p. 273), in which the views of Mr. W. Mattieu Williams and Mr. J. McElroy are expounded and discussed.

CORRESPONDENCE.

⁎ The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

CHANGES IN THE ELEVATION OF LAND ROUND THE BALTIC.

"The Swedish Academy recently published ("Nature," Dec. 18, 1884) observations made during the last 134 years, whose result is that the Swedish coast has been steadily rising, while that on the southern fringe of that sea has been falling, the zero line passing from the Schleswig-Holstein coast through Bornholm and Zöland. The northern part of Sweden has risen about 7 feet."

In "On some Properties of the Earth" (1880, p. 376) I said—"But this oscillation will be accompanied by local changes in the volume of the envelope of the earth," &c., "and by a local gradual rising and sinking of continents and seas."

"I presume that the greatest local elevation and depression, within the 595 years period, in the neighbourhood of the mean points and lines (*e.g.*, the Finnian North Cape, and on the same meridian near the Antarctic circle), amounts in both senses, in rising and falling, to 26 feet, or to 13 feet each way together to the 1÷595 part of the mean depth of the sea." With a uniform rise this would be 6·5 feet in 149 years.

O. Reichenbach.

THE BALANCE OF NATURE.

Since game preserving has been almost abandoned in Ireland, it is said that birds of prey have wonderfully increased in numbers and boldness. Kites were common and acted as scavengers in London, temp. Henry VIII., and perhaps the balance of Nature was not greatly affected by firearms till more than two centuries later, when Fielding said Tom Jones had "actually been known to hit a bird on the wing"; but a change was made in the latter part of last century, for my grandmother had difficulty in guarding my great-grandfather's chickens from kites about 110 years ago, but my father (who was born in 1800) never saw a kite in Yorkshire except once. He tells me an instance of the way in which numbers invite enemies: he has a cat which is a great bird-catcher, and, though you would not expect her to catch swallows, their numbers hovering over the little River Leen tempted her to try. She noticed that they turned from the river over the bank at one spot near a willow: there she lay in the grass, and sprang at them as they passed. One afternoon she brought five (martins) to my father's house.

Hugh Browne.

VEGETARIANISM.

Your occasional contributor, Mr. Mattieu Williams, has, in a contemporary of yours, advanced a novel and powerful argument in favour of Vegetarianism, *i.e.*, that the disuse of animal food would do away with what you well call the "barbarism" of permanent pasture, and would consequently arrest the depopulation of the open country and the deplorable crowding of the poorer classes into the great cities. But I fear he forgets the moorlands, marsh-lands, &c., which as grazing ground contribute their quota to the national larder, but, being quite unfit for plough or spade, would under a vegetarian *régime* have to be disused.

R. T.

[The moors and mountains might possibly be restored to their pristine condition, that of forests, and the marsh-lands could undoubtedly be utilised as osier-beds.—Ed. J. S.]

CREMATION *v.* INTERMENT.

I WAS much surprised to find that an eminent medical authority, when referring—in his recent lecture on Cremation—to the abolition of intramural burial, completely ignored the pioneer of this reform, Dr. G. Walker, long known as "Churchyard Walker." That this gentleman, who alone bore the heat and burden of the day, should thus be ignored is only another instance of the working of the "Sic vos non vobis" principle.

SANITARIAN.

ERRATA.

Page 258, line 3, *for* external world *read* exploded world.
,, 260, ,, 9, *for* natural sources *read* natural causes.
,, ,, ,, 27, *for* digresses *read* digress.
,, ,, ,, 35, *for* or so *read* and so.

NOTES.

A Vegetable Lubricant.—In the process of watching the expansion of a terminal bud from a twig of the horse chestnut, I noticed a flocculent substance clothing the petioles of the incipient leaves. Wetted and submitted to a magnifying power of 250 diameters, this substance presented the appearance of a convoluted cluster of perfectly round, transparent snakes, the ophidian extremities being, of course, excepted. I was reminded of a similarly constructed lubricating substance which I had seen many years ago in a hymenomycetous fungus, *Calocera viscosa*, and suspected that the function was alike in both cases. The friction arising from the simultaneous forward and lateral thrusts in the bud of a horse chestnut might be injurious if naked surfaces were in contact during the expansion. But what are the organs forming so perfect a lubricant? Are they modified trichomes,—appendages of epidermal cells? If only a secretion, like gum or mucilage, why should the snake-like forms be so definite? The sticky gum outside the bud is not so constituted. —(Read before the Microscopical Society of Liverpool, May, 1885, by Henry H. Higgins).

The poison of scorpions, according to M. Joyeux Laffuie, acts exclusively on the nervous system.

According to Prof. Thomas Meehan and M. Naudin ("Amer. Naturalist") sterility among hybrid plants is decidedly exceptional.

According to M. F. Folie (Académie Royale Belgique) a current of air rises from the point where it originates, and descends about the point where it terminates.

The "Zoophilist" has recently made an outrageous attack upon Prof. Martin, of the John Hopkins University, and has received a richly deserved castigation. According to "Science" the societies which support the "Zoophilist" include not only "ecclesiastical and courtly dignitaries, but, *proh pudor!* scientific worthies."

According to a contemporary scorpions remain motionless if any person blows strongly upon them in a vertical direction. We have observed the same fact in spiders and in various insects.

Says an occasional contributor to the "Journal of Science" "In England, compromise is the cardinal virtue, and consistency the only unpardonable sin."

The characters by which our predecessors sought to mark off one group of organisms from another are fading away. M. Duval ("Journal Anat. Physiol.") shows that birds possess a placenta, though in a rudimentary form.

According to MM. Pouchet and De Guerne the pelagic fauna of the Gulf of Finland closely resembles that of the large European lakes, as it contains in some parts as little as 0·073 per cent of saline matter.

F. Dahl, in the "Zoologisch Anzeiger," holds that spiders are very short-sighted, and judge by touch of the position of an object which falls into the web.

[This view is supported by many facts in the behaviour of the geometrical spiders.]

The flora of Ceylon includes 3000 flowering plants and 250 ferns: 100 genera of flowering plants found in Ceylon are not met with in the peninsula of India.

At Piltown, in Ireland, the inhabitants use as drinking-water the drainage from an over-crowded graveyard.

We regret having to record the death of Mr. F. Field, our highest modern authority on the mineralogy of South America.

The ovum of the *Ornithorhynchus* has, like that of birds and reptiles, a large yolk for the nutriment of the young.

The peculiar wingless and ground-haunting birds of New Zealand will soon disappear, as animals of the weasel tribe are being imported as a remedy for the rabbit plague.

We learn, from the "American Naturalist," that Dr. Woodrow, of the Theological School at Charleston, has been ejected from the chair for the offence of displaying Evolutionist leanings.

Prof. Noah K. Davis ("North American Review"), discussing the moral aspects of vivisection, concludes that "whosoever hinders the physiologist in his duties, by exciting public odium. commits a trespass on him and on society at large in whose interest he is labouring, and so does a multiplied wrong."

According to "Le Perigard" the western coasts of Europe have, since January, been affected every Saturday and Sunday with barometrical depressions and atmospheric disturbances.

M. Gautier contends that the production of alkaloids is a function of every living cell, animal or vegetable.

In the early morning of May 8th a temperature of 24° F. was registered at Aylesbury, and the following morning one of 28°. It is remarkable that these unseasonable frosts were accompanied by a wind hovering from S.W. to due W., but having all the features of the Polar current.

Earl Onslow, in the House of Lords, recently called upon the Government to "discourage" cremation. We are sorry to find that this great reform receives little support from our medical contemporaries.

M. A. Lavocat points out a new genus in the tetratological family of cyclocephalians. In individuals of this group, for which he proposes the name "ophthalmocephalians," the nose and the eyes are entirely wanting, the place of the orbits being occupied in the median plane by a cavity formed by the junction of the temporal fossæ. The vomer, the ethmoid, and the bones of the nose are entirely suppressed.

Syphilis has made its appearance amongst horses and mules in the neighbourhood of Burgos, and it is feared that the pest may extend to cows, &c. We suppose that the "Anti" genus will rejoice at the extension of the vested interest which they cherish.

Prof. C. E. Bussey ("American Naturalist") gives some interesting facts on the migration of weeds and grasses in Iowa and Nebraska. Old settlers say that notable migrations, not directly due to human interference, have been observed within the last twenty to thirty years.

A correspondent of the French Academy of Sciences observes that phylloxerised vines near Malaga, which had been considered as dead, have sent out vigorous shoots since the earthquakes of last winter!

According to "Cosmos" hens, ducks, and geese having a dark plumage lay earlier and more frequently than those of a light colour. This difference holds good only if the birds live in the open air and are freely exposed to the sun.

"Ciel et Terre" tells us that in France, since 1835, 4609 persons have been struck dead by lightning, 1000 have received fatal injuries, 4000 have been seized with momentary and temporary paralysis, and 20,000 have been struck without sustaining any injury.

The "Lancet" remarks, *haud inepte*, that if Mr. Mundella hopes to sweep back the tide of public opinion concerning the ruinous effects of educational over-pressure, he must find better brooms than Lord Aberdare and Sir Lyon Playfair.

Dr. Lydekker ("Geological Magazine") finds that the phalangeal bones in the British Museum referred to *Dromæus* *sivalensis* do not belong to a bird at all, but are the lateral toes of the fore foot of an even-toed ungulate akin to the hippopotamus.

M. A. Cornu ("Comptes Rendus") finds that in the spectra of the metals certain series of rays, spontaneously reversible, present approximately the same laws of distribution and of intensity as do the rays of hydrogen.

Mr. T. A. Jamieson ("Geological Magazine") gives reasons for supposing that the Mediterranean was at one time shut off from the Atlantic; that it was divided into two distinct basins by a land junction extending from Italy to Africa; and that most of its islands, notably Sicily and Malta, were in connection with the mainland.

M. P. Reynard has devised a means of studying the phenomena presented by deep-sea animals when submitted to a pressure of 600 atmospheres.

The eels of the lakes in the Forest of Vincennes perform every spring a pilgrimage to the Seine and the Marne, crossing several kilometres of land.

The Committee on Migration, of the American Ornithological Union, has now, according to "Science," observing stations in every State of the Union, except Nebraska.

According to the researches of Joseph Kleiber ("Astronom. Nachrichten"), the density of the inter-planetary medium at the mean distance of the Earth from the Sun lies between the limits 10^{-22} and 10^{-18} (water = 1).

Councillor Helm, of Danzig, has given his collection of 7000 Coleoptera and 3000 insects in amber to the Museum of West Prussia.

M. de Thierry ("Comptes Rendus") has devised an instrument—the hæma spectroscope—for detecting infinitesimal traces of blood in water, urine, &c. Its action is based on the properties of oxy-hæmoglobin, which gives two absorption-bands between the rays D and E, and of reduced hæmoglobin, which has a single band ("Stokes' band") between the two former.

Mr. C. O. Byrne ("Science"), though no Hampdenite, justifies the epithet of "fanatical pantheist" applied by the Zetetics to the great astronomer, and considers that "nothing can be more disappointing than many of the biographies of physicists, who, even in the most favourable instances, are but little great men."

In opposition to MM. Bouchard and Pouchet, M. A. Villiers ("Comptes Rendus") affirms that alkaloids exist only in pathological urine, and not in the normal excretion.

The "Alnwick Herald" asserts that a boy of 10 years of age, after being ill for three months, vomited a full-grown newt, and thereon completely recovered.

[We once incurred much obloquy for our want of faith in the story that a sickly girl had vomited a lively green lizard, *Lacerta agilis*, which was said to have immediately run away into a hedge.]

Mr. E. Bordoe, in a paper on "Browning as a Scientific Poet," said that, in the poem "Easter Day," Browning seemed to have anticipated by five years Herbert Spencer's theory of the evolution of the first rudiments of nerves in *Medusæ* along the lines of least resistance.

Two very prominent official *savants* will doubtless have resigned their appointments before this is in the hands of our readers.

Prof. O. Marsh proves that there has been a general relative increase in the size of the brain in mammals, birds, and reptiles from the Jurassic to the present time.

Some interesting cases of hermaphroditism in the human subject are being discussed in the medical papers.

In a paper on deaf-mutism an eminent religious organ asserts that all deaf-mutes are found to be entirely devoid of the God-idea,—in other words, natural atheists.

H. Traube ("Neues Jahrbuch für Mineralogie") has discovered a large mass of jade in the Zobtengebirge, near Jordansmühl, in Silesia. This observation is of great anthropological importance.

Dr. de Watteville, writing in the "Lancet," gives an account of the successful treatment of two cases of "writers' cramp," by Mr. Wolff, of Upper Berkeley Street. The agencies used were massage and Swedish gymnastics.

Mr. S. H. Scudder ("Science") contends that no "ordinal differentiation" can be traced in palæozoic insects, though all the existing orders were fully developed by the middle of the Mesozoic period.

Dr. Baur, in the same journal, mentions the exceptional occurrence of a rudimentary second cartilaginous phalanx in the third finger of the wing of an embryonic duck.

The mean duration of life in Bengal is 52·88 years as against 40·86 in England. Taking insanity, blindness, deaf-mutism, and leprosy together, the number of persons affected is in Bengal 3·8 per cent, whilst in England, though we have no leprosy, it is 4·49 per cent.

An apparent epidemic among ducks near Castres, in the department of Tarn, proves to be simply poisoning by the leaves of *Ailanthus glandulosa*, which these greedy birds had eaten in spite of "instinct."

The Rev. J. L. Zabriskie ("Journal of the New York Microscopical Society") shows that the ocelli of the hive-bees, notwithstanding their high convexity, must subserve remote vision, since they are hedged in by dense hairs, with openings suited only to command a view of distant objects.

Can it be believed that, so recently as the year 1880, a man of position and education could be ignorant enough to write in a popular periodical—"Man is distinguished from all other creatures by his possession of mind,—his powers of thought, judgment, and memory"!

2 JUN 1885

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JOURNAL OF SCIENCE.

JULY, 1885.

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I. "EVOLUTION AS APPLIED TO THE CHEMICAL ELEMENTS."*

By the Count O. REICHENBACH.

THERE was an article in "Nature," Nov. 6th, 1875, where Mr. T. B. Blanchard "supposed" this theory had not been discussed before. In consequence I sent the following paper to the Editor.† It was returned on December 5th, for "in the pursuit" "of the discussion" of the "great principle" "of Darwin," as applied "to the Chemical Elements," a distinguished scientist had informed Dumas, on December 3rd, that he made "observations" "indicating the breaking up of atoms of bodies hitherto regarded as elementary."

Seeing the absence of experimental and metaphysical progress, I contribute this phantasmagoria for the benefit of aspiring alchemists.

It would be hasty to affirm that we cannot succeed in mutating any element, but the metamorphosis of most, or perhaps all, of them may depend—like the creation of organisms—on circumstances and powers beyond our control.

---

* The article "Recent Developments of Chemical Science," in "Journal of Science" (January, 1885), is the immediate cause of this contribution.

† Written in 1862, preceded by "On the Atom and on Heat" (1861), and followed by "The Origin of Organisms" (1865).

The theory that elements are multiples of H evades proof and disproof, because it attributes observed fractions to experimental errors. But why should a new re-partition of a sum of matter, breaking up the unity H into fractions, not be a requirement of elementary mutation and evolution? Must it not follow from the mutual action and development of cosmic systems and masses? Do atomic weights represent dead weight only? Do they not include a tendency of motion imparted from a distance, and affecting different atoms differently under equal or similar circumstances?

Should we not bear in mind, in framing hypotheses of progressive growth and development of nebulæ, systems, cosmic masses, strata, molecules, and atoms, that looking round on earth, the home of all our experiences, and analysing the lights from heaven, we find some elements universal, others predominant, others frequent, less frequent, rare, and very rare? Must not the extent and frequency of formations correspond to that of causations? Is it, then, rational to represent evolution by an indiscriminate tabulation of elements, according to an assumed law of multiplicity of H?

I do not believe my hypothesis infallible, but in the right direction. I use the atomic weights accepted by Berzelius and Wöhler, except where stated otherwise, without pretending them to be free from error.

Hydrogen and hydrocarbons seem to entirely constitute some nebulæ and comets, masses in a nascent state. Nebulæ consist of gases, liquids, and solids. First H and O, then C and N. These elements compose almost exclusively our atmosphere and ocean, and enter largely in organisms and solids. $OH = Aq$, exceptional in many respects, is all-present in every form.

The relation of H, O, C, and N without fractions, made into a metaphysical toy, is not without interest. Equivalent $H = 1$ is composed of two atoms, mathematical points grown magnitudes; spaces become force, energy, mutual motion, attraction, and repulsion. Two such points describe and form a straight line, a dimension, of absolute length 2, —the equivalency H. Three such lines combine to a cube of energy, a volume, the space of three dimensions, $2^3 = 8 = O$, oxygen; the volume O coincident with a sphere is equal in size and form to one of the original points become magnitude and force, for the gas volume of H to that of O is $= 2 : 1$.

In weight $8H = O$; $(8 + 8 \div 2)H = 12 = C$;

$$(8 + 8 \div 2 + (8 \div 2) \div 2)H = 14 = N.$$

Observation finds the universal, primary elements,—

$$H=1;\ O=8{\cdot}01307;\ C=12{\cdot}250;\ N=14{\cdot}188.$$

The 0·01307 added to O is little, yet no determination of respective weights has been made more reliably. The 0·01307 represents a tendency of motion, a physical characteristic imparted to the metaphysical $O=8$ by the generation of our solar system. In 1857, independently of all this, I got as probable relation of planetary to solar mass, as result of an engendering opposition and motion,—

$$1 : 8{\cdot}8^3 = 1 : 681{\cdot}5;$$

the metaphysical $H+O$ became water, the egg of a system,—

$$9 \div 681{\cdot}5 = 0{\cdot}01321.$$

Equal spectra need not represent equal atoms for all systems; they may signify similarly proportioned motions under similar circumstances. Taking $C=12{\cdot}250$ we might conjecture $C=O+4H+1\div4H$ with an excess of 0·013. When 8C originated together,—*organically*,*—but one C splitting in two (the now preferred 6·125 × 2) united with 2O and liberated 0·013 × 8 from 8C, we get 7C at 12·250 and 2N at 14·188. In this manner we might build up a system. But we keep to the hypothesis applied to H and O; there is parallelism in the development of the system and its elements.†

In dealing with that development and the tension of vapour (*ref.*), I showed the meaning of the fifth power or root. C is the transition between H and O through the organic development within the molecule Aq; it is an organic skeleton,—

$$O \times \sqrt[5]{O} = 12{\cdot}260 = C.$$

The planetary mass decomposed into two masses, their residues being Jupiter and Saturn; they ejected two others, who divided each into four subordinate masses, split off.

---

* The great chemist Liebig, affirming elementary eternity, wrote—“The view that elements might be formed in organisms” “belongs to the time of childhood of natural science, but is at present unworthy of it.” Is it? Elements may be produced organically and inorganically. Where is the mechanical definition of either?

† *See* “Journal of Science” for February, March, and April, 1883, and “On some Properties of the Earth,” 1880. Referring to them I shall write (*ref.*).

In the lawful evolution of the system,—in the distribution of its masses, distances, motions, excentricities, and so forth,—we meet the relations—

$$1 : 1{\cdot}69 = 1 : \sqrt[4]{8{\cdot}013}\ ;\ \ 1{\cdot}72 = \sqrt[4]{9{\cdot}013}\ ;\ \ 1{\cdot}85 = \sqrt[4]{12{\cdot}260}$$

connected and modified by subordinate mutual disturbances. $1{\cdot}69 :: 1{\cdot}85$ produces the mean term 1·77, and—

$$8{\cdot}013 \times 1{\cdot}77 = 14{\cdot}188 = \mathrm{N}.$$

$1{\cdot}72 = 1{\cdot}83 \div 1{\cdot}049$ (*ref.*) brings $\mathrm{C} : \mathrm{N} = 1 : 1{\cdot}049^3$ (*ref.*). I group the predominant elements in the probable order of contemporaneous, successive, and continuous evolution from the Primaries; continuous, because the preceding elements do not vanish when the later ones increase in the condensing cosmic mass.

		Chlorine..	35·470		
Sodium ...	23·310	Sulphur...	16·120	Potassium .	39·257
Magnesium	12·686			Aluminium	13·716
Calcium ...	20·515			Silicon ...	22·211
		Iron ...	27·281		

$(\mathrm{N} \times 5) \div 2 = 35{\cdot}470 = \mathrm{Cl}$. N, circulating by solar action from and to Aq, becomes Cl; five N are made in one, condensed, and split—by organic fission, may be. Cl is, besides the primaries, H, O, N, the one element gaseous under ordinary circumstances, but differs by being coloured. "If chlorine be compressed, so as to reduce it to a volume five times less than it occupies at the ordinary pressure of the atmosphere, it becomes liquid, with the density 1·33" (Regnault, Chem.). The pressure which liquefies Cl at ordinary temperature is "four atmospheres" (Graham, Chem.). The gas Cl, with an equivalent and density 2·5 times that of N, reduced to $1 \div (2{\cdot}5 \times 2)$ its volume, becomes liquid when the pressure exceeds that of the atmosphere, as the surface of the Earth exceeds that of the electricity ill-conducting portion, the land, the $1 \div 3{\cdot}83$ of the surface; more elevated than the conducting sea, four times when the weight of the whole atmosphere to that of its portion resting on the land is considered. The excess in density, 0·33 of liquefied chlorine over density 1 of water, is 0·33; the addition is therefore $1 \div 4$ of the density of the new liquid generated in the sea, and corresponds to the preceding relation of atmospheric pressure, of the resisting non-conductor raised in Aq, whose conduction is increased by the accession of chlorine.*

Chlorine appears to exist through the whole system; when some of these relations seem quite terrestrian, I have shown (*ref.*) that everything terrestrian is, as integral part of the system, thereby determined.

Fractional differences arising in mutation may be compensated by complementary elements, and may therefore be realities, not errors, even if they could not be explained as tendencies of motion and otherwise.

The atmosphere consists almost entirely of O and N; the ocean of H and O; C is met all through. The predominant elements indicate, by the order in which they follow, their quantitative connection with sea or land. The sea contains more Cl than Na, more Na than Mg, more Mg than Ca, more Ca than Ka, more Cl than S. The percentage in the solids is the reverse. Potassium is in the sea combined with Cl, but this Cl is only 1÷1773 of the ocean; such part as solar gravity at the surface of the sea is of *g*; Ka is 1÷3546, as the mass of the sea is of that of the earth, &c. Ka is more of the land than of the sea.

Sulphur connects ocean and land. Al and Si disappear in the sea. Si is the chief element in the shell; and Fe, not found in sea-water, presumably increases—together with Si, O, and S—in the inner earth.

Sulphur, 16·120 = 2O condensed; the characteristic, 0·013 × 2, of the 2O becomes by the distribution of one H or unity 1÷8·78 (*ref.*) = 0·114, and S 16·114. Binoxide of H has a smell resembling that of ozone in formation, which reminds us of that of sulphur, which is that of the atmosphere after a stroke of lightning (!). 2O = 3S.

We may construct Na by N + Aq = 23·210,—

$$\mathrm{Na} : \mathrm{Cl} = 1 : \sqrt[5]{8{\cdot}78} \text{ and } \mathrm{N} : \mathrm{Na} = 1 : 1{\cdot}65', \text{ the } (\sqrt[4]{8{\cdot}78}) \div \div 1{\cdot}049 \text{ (ref.)},$$

meaning a decomposition of Cl into Na and C,—

$$35{\cdot}470 - 23{\cdot}210 = 12{\cdot}260.$$

Tertiary disturbances produce complementary elements, for instance, bromine = 78·392 about 3Na + O = 77·943; then iodine = 126·576; 5Na + AqH = 126·536;—

$$\mathrm{N} : \mathrm{Ka} = \mathrm{Br} : \mathrm{I} = 1 : 1{\cdot}65 = 1 : 1{\cdot}72 \div 1{\cdot}049 \text{ (ref.)}.$$

---

* This reminds of Oken in his "Natural Philosophy." I do not remember the exact words: "the sea becomes salted by the action of the sun."

$\mathrm{Ka} = 39{\cdot}257$; $\mathrm{Na} + \mathrm{S} = 23{\cdot}210 + 16{\cdot}114 = 39{\cdot}318$;
$\mathrm{Na} : \mathrm{Ka} = 1 : 1{\cdot}7$. Complement barium $= 68{\cdot}663$;
$\mathrm{Ka} : \mathrm{Ba} = 1 : 1{\cdot}75$.

After the " metalloids " we get the " alkaline metals," and pass to the " earthy metals." I place silicon last, and prefer the old 22·221 to the modern 21·3.

The preceding elements increased in weight, as products of the union and new re-partition of primary elements during the contraction of a semi-nebular agglomeration of solids, liquids, and gases, of imperfect separation and stratification, and of great alternations of contractions, expansions, and temperatures. The " earthy metals " represent the transition from sea to land ; the formation of more stable solids, by the reduction and decomposition of greater to smaller but denser atoms, requiring less pressure and less low temperature for solidity.

$\mathrm{Mg} : \mathrm{Al} = \mathrm{Ca} : \mathrm{Si}$, $12{\cdot}676 : 13{\cdot}720 = 20{\cdot}515 : 22{\cdot}211$:
: $\mathrm{Mg} : \mathrm{Ca} = \mathrm{Al} : \mathrm{Si} = 1 : 1{\cdot}75 \div 1{\cdot}07$ (*ref.*),
therefore $\mathrm{Mg} : \mathrm{Si} = 1 : 1{\cdot}75 = \mathrm{C} : \mathrm{Na}$.

Iron, the dominant metallic metal, has under ordinary circumstances $2{\cdot}83^2$ times the density of *ice*, $1 : 2{\cdot}83$ being the surface of land to sea, and the density of water to land (*ref.*). It is a good conductor of heat and electricity : it is the magnetic element, with a decidedly polar arrangement of the atom or equivalent $2\mathrm{Fe}$.

The generation of iron might be satisfied by various combinations, for instance, by the condensation and mutation of $2\mathrm{Al} = 27{\cdot}464$; but elementary generation is rather the re-distribution of matter in the abstract, not comparable to chemical combination. The earthy metals arose from the decomposition of the alkaline metals, with accession of the metalloids ; the metallic metals produced by greater pressure and condensation under greater heat show, with a re-combination of preceding atoms, a re-increase of atomic weights. When we look on the Earth as having been first a galvanic cell, then a battery, an arrangement of many cells, gradually become a dynamo-machine with a condensed thoroughly ferruginous nucleus, separated by a frictional, heated, mutating stratum from the insulating prominently silicious shell, whose outside is wound round by ocean streams, conducting and propelling electricity, moving between the separating insulating continents they raised by lateral pressure and motion, all wrapt into the di-electric air, traversed by conducting vapour, we form the proportion N : Cl = Si : 2Fe (the equivalency of Fe with its division into unequally constituted atoms),—

$$14{\cdot}188 : 35{\cdot}470 = 22{\cdot}221 : (27{\cdot}688 \times 2).$$

If the atom of Fe should have a characteristic in less or more (which I doubt, because the 0·688 is pretty near the 1÷40 of the 27)—(*ref.*), there is a group of complementary elements; atom Fe is then about equivalent to Cl − O. The density of liquid chlorine to solid iron is about 1·33 × 5·7; 5·7 is the density of the Earth, and a figure of mark for water (*ref.*).

S must prominently co-operate in the reduction of elements to Fe; therefore—

$$\mathrm{S} : \mathrm{Fe} = 16{\cdot}114 : 27{\cdot}688 = 1 : 1{\cdot}72$$

(manganese, 27·716; chromium, 28·191; cobalt, 29·568; nickel, 29·622; copper, 31·707; zinc, 32·311).—

$\mathrm{S} : \mathrm{Mn} = 1 : 1{\cdot}73$, $\mathrm{S} : \mathrm{Cr} = 1 : 1{\cdot}75$, $\mathrm{S} : \mathrm{Co} = 1 : 1{\cdot}83$, $\mathrm{S} : \mathrm{Ni} = 1 : 1{\cdot}84$,

and overstepping the boundary—

$\mathrm{S} ; \mathrm{Cu} = 1 : 1{\cdot}199$, and $\mathrm{S} : \mathrm{Zn} = 1 : 2{\cdot}07$, the 1·72 × 1·15 (*ref.*).

(Cadmium, 55·833; tin, 58·920; lead, 103·728).—

$\mathrm{Zn} : \mathrm{Cd} = 1 : 1{\cdot}72$, $\mathrm{Cu} : \mathrm{Sn} = 1 : 1{\cdot}77$, $\mathrm{Zn} : \mathrm{Sn} = 1 : 1{\cdot}8$, $\mathrm{Sn} : \mathrm{Pb} = 1 : 1{\cdot}75$.

(Boron, 10·914 (about O + 3H); fluorine, 18·734; phosphorus, 31·536). $\mathrm{B} : \mathrm{F} = 1 : 1{\cdot}7$, $\mathrm{F} : \mathrm{P} = 1 : 1{\cdot}73$.

Selenium, 39·631 (near Ka as Mg to C).—

$$\mathrm{Se} : \mathrm{Ba} = 1 : 1{\cdot}71, \text{ and } \mathrm{Ka} : \mathrm{Ba} = 1 : 1{\cdot}72.$$

Strontium, 43·854 to Ba only $\sqrt[5]{9{\cdot}013}$, to Br 1 : 1·78, but—(Arsenic, 75·330; antimony, 129·244). $\mathrm{Sr} : \mathrm{As} = 1 : 1{\cdot}72$, $\mathrm{As} : \mathrm{Sb} = 1 : 1{\cdot}72$.

Bismuth, if 71·070, to Sb 1 : 1·73, Bi and Sb standing quite opposed in the thermo-electric series. Others take Bi 71·070 × 3.* Bi is almost always "native." It has no proportional respondent element, bringing it within the stricter limits of the development of the system. Is it all terrestrian? is it no element? When Bi = 71·070 × 3, or the equivalent *three* atoms, we get 2Fe : Bi = 1 : 3·83 as the non-conducting part to the surface of the Earth, &c.

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* In "On the Atom and on Heat" I saw reasons to prefer this figure. I discussed at length the cause of the thermo-electric position of Bi and Sb, and the reasons why the elementary quality of Bi, and far more of Hg, might be doubted; or which might be, if they were elements, the causes of the distinctive features which seemed to separate them from the systemic elements, and which were the nature and characteristics of what might be called the transition or intermediate elements.

Silver, 108·305, to gold, 199·208 = 1 : 1·83.

Palladium, 53·359, to platinum, 98·841 = 1 : 1·85, &c.

The "development theory" gives the origin of the relations 1 : 1·7, 1 : 1·72, 1 : 1·85, marking the extremes and means of solar distance in the motion of the two great planets, the motion of the system having its correspondence in the central mass, and their continuity in ascent and descent of proportions, of mutual disturbances within the whole system. The return of similar relations of atomic weights between kindred elements, and prominently between the dominant elements, is therefore significant for the metaphysics of elementary evolution.

I have not yet mentioned mercury—a rare, yet important, and in its qualities exceptional, element. The atom is 101·431, to which applies what was said of Bi. It is next above the suspected Bi in inferior electric and thermic conductivity. Hg : Cl = 101·473 : 35·470 = 2·83 : 1 as sea to land, or, inversely, the density as the conducting to the insulating surface of the Earth.

Like H, it has and has not characteristics of a real metal. The atomic weight of this poor conductor is 8·013 – 1 = O – H less than that of the prominent conductor, silver. Hg is liquid at ordinary temperature, and dissolves most metals directly; when warmed, tin, lead, zinc, bismuthum, a group, the two latter evaporating with Hg in rectification. It easily dissolves gold and silver. For the extraction of silver from its ores, $NaCl_2$ is added to Hg; the metallic water moistening the ores is made ocean water; the proportion of weight in HgCl combining with Ag is—

Hg 74·09 : Cl 29·97 = 2·83 : 1,

the relation defined. The density of Ag at ordinary temperature is to that of solid Hg, at –40° C.,—

10·542 : 14·391 = 1 : 1·33 = water to liquid chlorine.

The limits of liquidity are for Hg –40° C., for Ag near 1000° C., water at 0° being the standard limit, 40° to 966° = 1 : 24·16 (*ref.*).

The equivalency of iron, 2Fe : Hg = 1·182, as their density when both are solid. Their conductivity is Fe ; Hg when both solid, 5·7 : 1 ; when Fe solid, Hg liquid, 6·7 : 1,—both characteristic figures for Aq (*ref.*).

Mercury freezes near −40° C., a characteristic temperature for vapour of water tension (*ref.*); it boils about 360° C.; its evaporation becomes perceptible beyond 32° C. The change of temperature between freezing and boiling of water is 100° C.; it is 400 for Hg, four times more; for ocean water 3·83 times more. Water expands by freezing, 1÷12·08 (polar zone of the hemisphere), and from 0° to 100° 1÷24·016, with greatest contraction at 4·13° C. (*ref.*). Mercury expands for each degree between 0° and 100°, the 1÷5550, towards −40° less, towards 360° more. Hg therefore expands, for equal change of heat, 2 to 1·95 less than water or ocean water, or $\sqrt{4}$ to $\sqrt{3{\cdot}83}$ less. Hg expands from state to state 1÷12·08, the double of water.* The densities of Hg being 13·88 at 4° C., and 14·39° at −40° C., the density of solid Hg is $3{\cdot}83^2 = 14{\cdot}66$ that of water—diff. 1÷59·56 (*ref.*).

This shows a curious similarity and reciprocity between Aq and Hg. Is mercury a large atom combined with H?

In the original paper there were remarks about the making and unmaking of elements, and propositions for experiments with I, Br, Chl, and Hg; but being no experimentalist I had better abstain from such suggestions.

II. THE COMPOSITION OF SEWAGE.

By J. W. Slater.

STRANGE to say even professed sanitarians, municipal authorities, and the like, not to speak of educated and intelligent people in general, have often very vague notions concerning the nature of sewage. They know that it is nasty, and contains various matters unsightly and offensive. But they are little aware of its complexity and of its liability to vary, according to the locality, the season, and even the hour of the day. Were these points better understood many futile processes would never have been proposed, and if proposed would never have been entertained.

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* Water expands 1÷12·08 when become ice; mercury contracts about 1÷12·08. Bi is said to expand when again become solid after liquidity at 265° C. (Marx), but this may be not quite true, as pointed out in "On the Atom."

I will take first the simplest case, that of a "residential" town. By this term sanitarians mean a town where few, if any, manufacturing operations are carried on, and where the liquid refuse is chiefly of domestic origin. As examples may be mentioned Oxford, Bury St. Edmunds, Leamington, Keswick, &c. The sewage of such towns is generally of a concentrated character, and the matters which it holds in suspension and solution are for the most part of an organic and a readily putrescible character. It contains the solid and liquid excretions of the inhabitants, the urine of horses and cattle discharged in the streets, the drainage of stables, piggeries, &c., the blood (more or less) of the cattle killed in the town, and the washings of slaughter-houses. Another important constituent is the water which has been used for washing the persons of the inhabitants, their clothing, their cooking utensils, &c. These slops, as they are called, are very offensive; they hold in suspension and solution soap, fatty acids, the juices of meat and vegetables, and the exudations from the human skin. Almost everyone must have observed that if a bowl of suds from "washing day" has been allowed to stand, it gives off in a very few hours a most unpleasant odour. There are also certain organic substances not offensive, nor readily capable of putrefaction, but which nevertheless play a very important part as far as the treatment of sewage is concerned. Thus a very large quantity of waste paper finds its way into the sewers, and is there subdivided into particles which quite escape the notice of an inexperienced observer. To these are added fine filaments derived from washing linen and cotton articles, and to a less extent from woollens. I say to a less extent, not because woollens when washed give off a smaller quantity of fibre, but because the total amount of woollens washed in a residential town is much smaller than that of cotton and linen fabrics. These filaments of textile materials and of paper are scarcely perceptible on a hasty examination. A glass of sewage, held up to the light, if not rendered turbid by suspended clay, road-silt, &c., appears almost as limpid as ordinary river- or pond-water. But if we attempt to filter it through the filter-paper used by chemists we find that the flow, though tolerably rapid at first, is quickly retarded, and before long comes practically to an end. If the liquid is then carefully poured away from the filter-paper, and a small portion of the latter is examined with the microscope, it will be found coated with the above-mentioned filaments of textile matters, which effectually choke up its pores. If we attempt to filter sewage through coke, asbestos, gravel, sand, peat, or ordinary arable soil, the same difficulty is encountered, the rapid flow observed at first becoming sooner or later obstructed. Hence, as I shall endeavour to explain more fully below, filtration is practically useless even for freeing sewage from its suspended impurities.

There is another constituent of sewage harmless in itself, but which seriously interferes with most processes of treatment. I mean the sand, gravel, and pulverised stone which are washed into the sewers by every heavy shower. I show elsewhere how this silt, &c., by keeping bad company, acquires offensive properties. Its inconvenience in every form of sewage treatment will be duly noticed.

In a manufacturing town or district the sewage is of a much more complicated character, and is more unsightly, though not more dangerous to public health. Nay, sometimes its purification is easier than that of the sewage of a purely residential town.

The pollution reaches its greatest height where the textile, tinctorial, and chemical arts are carried on. Here we find in the sewage, in addition to excrementitious matters, &c., sulphuric, hydrochloric, and nitric acids, alkalies, soap-lyes, solutions of iron, zinc, tin, alum, copper, chrome, antimony, and arsenic, waste dye-liquors and spent dye-wares, glue, sizes, waste tan-solutions, &c. It must not be supposed that all these substances will be found in the sewage of a manufacturing town at one and the same moment. Many of them, indeed, neutralise and precipitate each other,—a circumstance on which is founded a simple process for dealing with liquid industrial refuse. But if we watch the flow of such sewage we shall find striking changes both in its colour and its odour, according to the kind of filth just emitted by one or other manufacturing establishment. I have often seen some agent proposed for sewage-purification fulfil all requirements for hours in succession, but on the sudden discharge of a new kind of impurity into the sewer it has been found not merely useless, but even injurious, actually intensifying the evil.

The sewage of such towns, it may be observed, though containing a larger proportion of solid matter, both suspended and dissolved, than that of a residential town, is of far lower agricultural value—a point to be had in remembrance in selecting a method for its purification. Some of its possible ingredients, indeed, such as proto-salts of iron (ferrous salts), alkaline sulphides, &c., are not merely useless to vegetation, but positively injurious.

The sewage of districts engaged in the metallurgical arts, the manufacture of hardware, &c., contains little extra organic impurity. On the other hand, it often holds in solution iron in considerable amount, derived, *e.g.*, from "pickling" iron wire. Copper and tin are rarely present, the value of their solutions being a guarantee that they will not be knowingly and wilfully run into the sewer. But the proto-salts of iron—*e.g.*, ferrous chloride, formerly known as muriate of iron, produced whenever metallic iron is scoured or cleaned from rust by means of hydrochloric acid (muriatic acid, spirit of salts)—is abundant in certain kinds of sewage, and is not merely hurtful to crops for the time being, but is a permanent steriliser of the soil.

The sketch of the sewage of manufacturing towns just given is of course very general. Each such town, in fact, turns out a special quality of sewage, the nature and effects of which can be understood only after careful experiment and observation.

Both in residential and in manufacturing towns there is generally a very marked difference between the day and the night sewage. In a residential town the sewage, from midnight to 5 or 6 in the morning, is very much reduced both in quantity and in strength. Often it consists of little more than the surface-water from the streets and roofs, &c., and of the ground-springs, which often find their way into the sewers to a considerable extent. As the day advances the flow of sewage becomes more abundant and more offensive, and is at its worst from 2 to 8 p.m., or thereabouts. In manufacturing towns the difference between the day and the night sewage is less marked, since certain kinds of waste waters are discharged in the night if requisite, and refuse which should not rightfully be run into the sewers at all is often introduced when there is the least chance of observation. Hence it is a serious mistake to imagine that the night sewage may be safely neglected, and allowed to pass into the water-courses without purification.

On Sundays in a residential town the sewage differs little, if at all, from its condition on the other six days of the week. In manufacturing towns it is on Sundays more purely excrementitious in its character, the industrial waste waters being in great part wanting. The same holds good with respect to public holidays. In small agricultural towns the sewage on market-day is very perceptibly stronger than on other days, and requires an extra share of attention.

The question has often been raised whether there is any marked difference between the sewage of a "closetted" town and one where a part, larger or smaller, of the population make use of the old-fashioned cesspools, or of dry earth-closets and similar appliances. Certain authorities, on the faith of their analyses, have maintained that there is little or no difference in the strength of the sewage. Careful consideration will show that this is scarcely possible. It may be at once admitted that the liquid excrements of man, and of all analogous animals, contain a larger proportion of nitrogenous matter than do the solid excreta. But in a closetted town the whole of the excrements of the population, liquid and solid, find their way into the sewers, and thence into the river. In an unclosetted town not merely the solid, but a large part of the liquid excretions are discharged into the cesspools, dry closets, &c. Very frequently also, in small straggling towns, public urinals, if they exist at all, are not connected with the sewers. Thus the water running in the latter consists to a great extent of soapsuds, the washings of plates and dishes, and, in short, what is technically known as "slops." I do not see, therefore, how it is possible for the sewage of an unclosetted town, other things being equal, to be as rich in nitrogenous matter as that of a thoroughly closetted town.

A very important consideration is the water-supply, known and unknown. By the known supply I mean the average quantity per head of the population served out from the water-works. By the unknown I mean the quantity which leaks into the sewers from other sources. Where the sewerage system lies in a wet sub-soil, with many ground-springs, and where the sewers themselves are not water-tight, the flow of sewage in dry weather may rise to 100 gallons per head of the population per twenty-four hours, whilst in towns where the water-supply is scanty, or where the sewers are well made, it may fall as low as 20 gallons.

Another very important distinction is the space covered by a town in respect to its population. Where the streets are wide, where there are few persons to a house, and where there are many gardens, paddocks, vacant spots of building ground, &c., the sewage, especially in wet weather, is so much diluted that it loses all its distinguishing properties, and is little worse than ditch-water.

This brings us to the question of single or double sewerage. It is suggested by many engineers that the water-closets, the domestic sinks, the public urinals, &c., should discharge their contents into one set of sewers, whilst the surface-drainage is carried away by a distinct system. It must be admitted that this double system has some decided advantages: the sewage, properly so called, would be at all times much more nearly alike in strength and quantity, which would facilitate its treatment, whether by irrigation, filtration, or precipitation. Its value would be also much greater. On the other hand, the expense of the double system is a very serious consideration. The water from the street-gutters, though receiving nothing from the urinals and closets, will be far from clean, and its admission into the streams will be very doubtful. In manufacturing towns there are many waste liquids,—*e.g.*, the rinsing-waters from dye-works,—which if run into the sewage will very much dilute it, but if allowed to pass into the rivers will greatly spoil their appearance.

Lastly, it is sometimes found, even where the ordinary single system prevails, that the sewers require flushing to prevent solid matter from being deposited in parts where the gradient is insufficient. It is reasonable to suppose that this will be much more frequently the case in a sewer which carries fæcal matters only, undiluted with surface water. Here, then, we should get back, occasionally at least, to that dilution of the sewage which was to be avoided by the double system.

III. THE PARASITES OF CIVILISATION.

LET no galled jade wince! We are not about to discuss the "social parasite"—the schizomycete in human guise, who, by a necessity of his pathogenic nature, seeks to split up faiths, societies, empires, into sects, cabals, and factions, just as his prototype splits up healthy cells and converts them into ptomaines. With such parasites we have no concern. Our object is to view the vegetable and the infra-human animal world in its relation to civilisation,—not exclusively and necessarily to civilisation as now existing, but to any and every possible civilisation.

From this point of view, then, we may divide the organic world into several classes. First come those which have entered into human civilisation, and assumed a more or less important part in it, as domestic animals and cultivated plants. As such they minister to our necessities, our convenience, our pleasures, our follies, and our vices. But with this important class we have here nothing to do.

Again, there is a very numerous class of organisms which remain outside of human civilisation, and occupy a more or less independent position. Such organisms may be hostile to us, or neutral, or, even in the result of their life-work, friendly. They may be useful or useless from a human point of view; but they have these points in common, that they do not lend themselves to domestication or common cultivation, but retire from the face of man, and become less numerous in proportion as any country is more thickly settled and is brought under general cultivation. As examples we may mention the wolf, the bear, hyena, wild swine, wild ox, hostile to man and long ago extirpated in Britain; the stork, the roller, the golden oriole, harmless or even useful, and extirpated also; the goldfinch, kingfisher, "scarce swallow-tail" butterfly, and red underwing moth, all harmless, but becoming rarer from season to season, and, without some capital change in the habits of the public, doomed to certain extirpation.

With those animals and plants which we have named the parasites of civilisation—animal and vegetable—the case is utterly different. They are all hostile to man, doing him great injury either in his person or his possessions. But instead of receding from man, or of growing scarcer as he becomes more numerous, more powerful, and wealthier, they actually "grow with his growth and strengthen with his strength." This is, in fact, the reason why we term these beings "parasites on human civilisation" rather than simply "parasites on man." Not a few of them, as we may have to emphasize below, are nearly harmless to the wandering savage, but formidable to the dweller in cities or in highly cultivated plains.

A peculiarity of these parasites—weeds and vermin—is that civilised man, for the most part unwittingly, and we may feel sure unintentionally, introduces them into "new countries" when he goes to settle there, or introduces them to his home in the course of trade. In this manner the grey or Russian rat has been conveyed round the world.

In this manner numerous vile weeds have been introduced into Australia and California; the house-fly, the "cabbage white," and the Hessian fly into North America; the *Phylloxera* into France; the bed-bug and the cockroach into Europe generally; the chigoe into tropical Africa; and multitudes of other undesirable species have been imported into regions where they were formerly unknown, and where their room would be much more desirable than their company.

Cases have happened where parasitical animals have been introduced by man into new countries knowingly and wilfully, but from ignorance of or mistake as to their probable behaviour. Under this head may be mentioned the conveyance of the thistle to Australia, and of the European sparrow to the United States,—both unfortunate experiments, regretted by the public at large, if not by their ill-judging perpetrators.

If we cast a glance at the entire series of these parasites we find them, at least as far as animals are concerned, distinguished by a relatively small size. Hence they are able the more readily to conceal themselves from hostile search. Conjoined to small size, we find prodigious fecundity. Hence though the individual is feeble, the species is mighty. We may think them extirpated, but, if only a very few have escaped our pursuit, a short time sees them as numerous and as destructive as ever.

Another important feature in parasites, or at least in a very large proportion of them, is a nocturnal or—what amounts almost to the same thing—an underground life. Everyone will here be reminded at once of the mouse and the rat, the snail and slug, the bed-bug and cockroach, the mole-cricket, the larvæ of the cockchafer, the wireworm, the crane-fly, which work havoc beneath the soil,—not to speak of the *Phylloxera*, which attacks principally the roots of the vine. It needs little reflection to show how nocturnal and subterranean habits must withdraw any animal from ordinary human observation, and as a matter of course from attack.

Another feature, almost universal, is tenacity of life, and power of supporting great differences of climate, and other of the conditions of life. Without such tenacity, indeed, few plants could be weeds, and fewer animals could rank as vermin. For the latter, to be omnivorous is an important qualification. The rat and the mouse feed either upon vegetable or animal matter, whether living or dead. Almost all the slugs and snails will consume animal food, egg, grease, and human excrement, as readily as plants, growing or decayed. The sparrow is omnivorous, though it greatly prefers grains, fruits, &c., to flies and larvæ. The house-fly is the very type of an omnivorous animal. It consumes all the varied substances which enter into the diet of man, and a few more. Our most rampant weeds are proverbially hardy. With many nothing will kill them save individual extraction from the soil and consumption by fire. But, in a clayey soil, to remove every fragment of the root of a wild convolvulus is almost an impossibility. We have been told by a labourer who had been employed in laying the sewers of a country town that the roots of this weed were traced down to a depth of eleven feet. The tenacity of the dock, the thistle, the buttercup, the dandelion, and the groundsel is well known, and few indeed are the fields, or even the gardens, which are completely freed from these enemies.

Perhaps we have here a consideration which may lead us to a definition—approximate at least—of vermin and weeds. There are, as we have already mentioned in passing, animals, such as the wolf and the lion, which, though hostile to man, undergo extirpation wherever civilisation is thoroughly established. Had France and Spain been for a couple of centuries occupied by the American people, it is safe to say that not a wolf would have survived down to this day. These animals, and many more that might be named, being extirpable and retreating before civilisation, cannot be called "vermin." In a similar manner there are many plants which we do not cherish and cultivate, and which have, indeed, nothing to recommend them, but against which we do not need to take any special precautions. Such plants, therefore, can scarcely be called "weeds."

It is interesting to compare, when opportunity offers, a plot of land which has never, as far as is known, been subjected to cultivation, with another plot of similar soil which has once been cultivated, but has subsequently been left to what we may curiously call "Nature." Between the respective floras of these two plots there is a wonderful difference. The originally untilled plot contains an average assortment of the wild plants of the district. The plot which has been deserted will be found, as a rule, stocked exclusively with the most characteristic "weeds,"—vegetable species which seem to be fostered by cultivation, unless it is of the most thorough-going and persistent character.

This brings us to another essential point: these parasites of civilisation, vermin and weeds, are notably ugly. Many wild animals of the most different groups are exceedingly beautiful. But where is the beauty, from a human point of view, of the rat, the mouse, the cockroach, the bed-bug, the chigoe, the flea, the crane-fly, the wireworm, and the bulk of their associates? Perhaps the Colorado beetle is the only tolerably looking animal species which is at once hostile to man and increases at the approach of cultivation.

With the plants parasitic upon human civilisation the case is very similar. Name our chief weeds, as distinct from wild plants, and you name those which have the least claims to beauty. Their flowers, if sufficiently conspicuous to be called "flowers" in the popular sense of the term,* are for the most part yellow. Now at the risk of being called Philistines by the Æsthetic School, we must mention that yellow flowers must be assigned to the lowest rank. Nature seems to produce them with the greatest ease, just as the British workman turns out jerry-work, without special effort or attention. A weed with a large conspicuous blue, purple, or crimson flower would be something out of the common track.

In this connection we come upon the curious fact that no true weed—no plant which thrives all the more luxuriantly for the labours of the husbandman and the gardener—gives off fragrance, either from its flowers or its leaves. Many of them, on the contrary, are decidedly offensive, or at the best scentless.

Another noteworthy circumstance is that so many of our worst plant-parasites on civilisation belong to the order of Compositæ, to which some botanists assign the highest rank in the vegetable world; plants which flourish as being eminently adapted to present conditions, and are consequently—success being now the received test of merit—entitled to pre-eminence. They may be considered as in some sort analogous to the financiers and usurers who, under the star of Judas Iscariot, thrive best among us men of the nineteenth century.

It is singular, and not by any means cheering, that the exceptional power of multiplication, and the tenacity which we have noted in vermin and weeds, should be so singularly connected with inutility and even positive harmfulness to man,—with ugliness, as shown in the absence of brilliance and perfume, and with mean or insignificant forms. So sure as an animated being pleases us with its beauty, solaces us with its song, and leaves our persons and property uninjured, so surely we find it comparatively rare, decreasing in numbers, and hovering on the very verge of extinction. So sure as a wild plant is pleasing to us by its form, its colours, and its fragrance, its preservation seems to task all our efforts. A beautiful or a harmless animal or plant never, we believe, becomes naturalised in any country by accident. With the ugly and the noxious animal and plant the converse holds good. The utmost we can effect against such of these as come under the category of the parasites of civilisation is to keep them at bay, to prevent their increase. How we have to watch against the immigration of new vermin and weeds, and how often do they elude our vigilance!

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* Surely we want here a word, or a pair of words, to distinguish flowers which have a conspicuous corolla, calyx, or both, from flowers in which these parts are wanting, or are so slightly developed as to escape the notice of the general public.

Why this disconnection between beauty and utility, on the one hand, and vitality and fecundity on the other, should exist is an unsolved problem. Many attempts at an explanation have been made, but none of them have proved acceptable save within very narrow limits.

Some say that we consider beautiful chiefly what is rare, and loathe, or at least ignore, whatsoever is common. This suggestion by no means holds good. There are many districts where, *e.g.*, the mountain- and the cross-leaved heaths (*Erica cinerea* and *E. tetralix*), harebell, the wild wood-hyacinth, the forget-me-not, are as abundant as are in others the veriest weeds. Yet no man fails on that account to recognise their beauty. On the contrary, they seem far more attractive in masses than when scattered singly. So the question of rarity or abundance is not to the purpose.

Another explanation advanced is that certain animals and plants are extirpated on account of their very beauty, whilst the ugly are passed by. In this there is unfortunately a certain amount of truth. The shady coombes of Devon are being plundered of their delicate ferns, and the woodlands of Kent and Suffolk stripped of their lilies of the valley, by dealers and their emissaries. We know not a few localities where choice wild plants have flourished within a few years, of which now not a trace remains. We fully admit that any rare and beautiful bird showing itself in this country is at once shot down, to be exhibited as a "British specimen" of so and so. We know, and had we the power we would visit with crushing penalties, the destruction of humming-birds, trogons, birds of paradise, &c., at the dictates of fashion and ostentation. But all this does not go to the real root of the difficulty. Every farmer and every gardener wages against weeds a war far more general and systematic than that carried on by dealers against the oak-fern, the beech-fern, or the lily of the valley. Yet the weeds survive in the face of this crusade, whilst the beautiful plants do not.

One point, indeed, must be remembered, *viz.*, that our lovely wild flowers and ferns are limited in their choice of localities. The devastation of our woodlands deprives them, in many cases, of the only spots they can inhabit, whilst the weeds can accommodate themselves to changes of soil and exposure. But this is no explanation; it is merely a restatement of the question. We have still to ask *why* our beautiful wild plants have, as compared with weeds, so little tenacity and adaptability?

In comparing beautiful birds or insects with vermin, we meet the very same difficulty. The sparrow can outlast an amount of slaughter or capture, far more than enough to sweep away the nightingale, the goldfinch, or the kingfisher not merely from Britain, but from the entire earth. The hawk-moths and red underwings are perishing beneath the attacks of collectors; but the cabbage-whites, the cabbage-moth, and the magpie-moth seem little affected by the wholesale slaughter of their larvæ which are carefully picked off the cabbage-plants, turnips, gooseberry- and currant-trees, wherever seen, besides being treated with appropriate poisons.

A more sensible answer has been given by an American writer, which, as far as it goes, may be fully accepted. He contends that our choice flowers, fruits, and vegetables are absolutely artificial productions, out of harmony with the natural flora and fauna of the district where they grow, and can be preserved only by a maintenance of the artificial conditions under which they have originated. The *raison d'être* of the cultivated fruit or flower is man's convenience, advantage, or gratification. It has been modified by him to that end without reference to its power of succeeding in the struggle for existence.

Further, cultivation presents a number of plants in vast masses together. This is a demand which creates a supply of enemies. Just as for a conflagration we must collect together a large quantity of combustible matter, and as for an epidemic we must have a dense population, so for the recent development of the Colorado beetle we must have potato-fields, and for the ravages of the *Phylloxera* we must have extended vineyards.

But this consideration meets a part only of the difficulty. The question still arises, why, among natural species of plants and animals, totally unmodified by man, we find the same difference,—the ugly, the useless, and the pernicious being more prolific and more tenacious of life than the useful and the beautiful ?

We must therefore hazard the suggestion that the attainment of what strikes us in beauty, whether in form and colour, or in sounds emitted and fragrance given off, must in reality be an exhaustive strain upon the resources of either animal or plant. If this is the case the organic world is not developing in the direction of beauty, and the ugly shall inherit the earth.

In concluding we must raise the question, In which of the divisions of the animal and vegetable worlds are the parasites upon civilisation mainly to be traced ? Among mammals there are few, all rodents,—the mouse, the rat, and some allied species. The squirrels are certainly enemies of man, as attacking and injuring not a few of his cherished possessions, and destroying harmless and beautiful wild birds. But they recede before increasing population, and find no shelter in our cities, so that they cannot rank among the parasites. One of the worst features of the parasitic rodents is that they furnish a pretext, at least, if not an actual necessity, for the cat and the terrier,—two most objectionable animals, the dread of all who love flowers and birds.

Among birds we can name only one truly parasitic species —the house-sparrow. This bird has not a single redeeming feature, and has beyond doubt multiplied, *pari passu,* with the development and the spread of civilisation. His worst feature, next to the unfortunately successful war which he wages against the martin and swallow, is that we can scarcely extirpate him without scaring away useful and harmless birds.

Of reptiles, amphibia, and fishes, none, from their very nature, can rank as parasites upon civilisation.

The invertebrate parasites space will not allow us to discuss in detail. Among mollusks are the terrestrial snails and slugs, and among insects a very considerable number.

IV. ON THE SPONTANEOUSLY REVERSIBLE SPECTRAL RAYS,

AND ON THE

ANALOGY BETWEEN THEIR LAWS OF DISTRIBUTION AND INTENSITY, WITH THOSE OF THE RAYS OF HYDROGEN.

(Concluded from page 352.)

Particular Arrangement of the Spontaneously Reversible Groups.

WHEN we examine, in different photographic proofs, the groups of rays which are reproduced periodically with an especial regularity, we find most frequently that these groups belong precisely to the category of the spontaneously reversible rays, for some of them are reversed and the others are on the point of being so: for one and the same metal the reversals are more or less complete according to the conditions of the experiment, and for different metals according to the chemical and physical properties of the metal. Further, the law of the distribution of these groups presents another character common relatively to the succession of distances and of intensities: the rays become more and more close together towards the more refrangible side, decreasing at the same time in intensity. This feature is the more striking as the number of reversed rays is more considerable, and as the field upon which they are detached is more uniform. It seems as if, with the rise of temperature, the spectrum tends towards a final aspect,—that of a continuous brilliant ground, devoid of every ray other than the regular series of the spontaneously reversible rays. It is to this constitution, which is to some extent ultimate, that M. Cornu wishes to draw the attention of observers.

The number of metallic spectra which can give a regular series of spontaneously reversible rays is very considerable; but the first series hitherto observed are furnished by two metals which, from a chemical point of view, we should not expect to find side by side. These are aluminium and thallium, whose atomic weights figure about the extremities of the list of elementary bodies.

Analogy with the Distribution of the Rays of Hydrogen.

M. Cornu does not stop to indicate the fruitless attempts at numerical calculations which he undertook with the view of representing each of these series by the substitution of the series of whole numbers in a simple function. He had abandoned these researches when the beautiful discovery of Dr. Huggins on the spectra of the white stars brought back his attention to the subject, and opened up to him a new horizon. These spectra present a common series of dark rays,—that is to say, reversed rays,—fulfilling precisely the conditions of distance and intensity which characterise the spontaneously reversible rays in the metallic spectra. This series prolongs the series of the well-known rays of hydrogen, C, F, G′, *h*; we might then foresee that the entire series would participate in it. This has been since confirmed by the researches of Vogel, though still leaving some uncertainty. The interest of this identification was such that M. Cornu undertook to verify it himself, which he has only just effected. The experiment is not free from difficulty, but by taking more and more minute proportions to remove the impurities of the rarefied hydrogen gas he has seen the foreign rays successively disappear, and he has finally succeeded in obtaining photographic proofs offering the series of astral rays in all their purity.

The following proposition summarises the result of these researches:—

> "In the metallic spectra certain series of spontaneously reversible rays present the same laws of distribution and intensity as those of hydrogen."

V. MR. A. R. WALLACE, F.R.S., ON THE RELATIONS BETWEEN SPIRITUALISM AND SCIENCE.

By R. M. N.

IT is no longer possible to ignore the phenomena known collectively under the name of Spiritualism. Unwelcome as these facts may be to many of us, serious as are the conclusions to which they seem to lead, there is nothing to be gained—and possibly there may be much to be lost—by persisting in an attitude of blank sweeping denial. At all events let us know the worst. If the new revelations, as it seems to me,

> " Cast on all things surest, brightest, best,
> Doubt, insecurity, astonishment,"

we must still seek what basis, if any, is left for law and order. It is therefore that I took up with eagerness Mr. Wallace's paper (" Light ") which I am about to examine. Surely, I thought, he, more than perhaps any living man, will be able to show a harmony between Science and Spiritualism.

My hopes have been but very partially fulfilled. To me Mr. Wallace seems to pass over the points which underlie the repugnance with which men of Science regard Spiritualism and its advocates. Mr. Wallace writes :—

" It is a common, but I believe a mistaken, notion, that the conclusions of Science are antagonistic to the alleged phenomena of modern Spiritualism. The majority of our teachers and students of Science are, no doubt, antagonistic, but their opinions and prejudices are not Science. Every discoverer who has promulgated new and startling truths, even in the domain of Physics, has been denounced or ignored by those who represented the Science of the day, as witness the long line of great teachers from Galileo in the dark ages to Boucher de Perthes in our own times. But the opponents of Spiritualism have the additional advantage of being able to brand the new belief as a degrading superstition, and to accuse those who accept its facts and its teachings of being the victims of delusion or imposture,—

of being, in fact, either half-insane enthusiasts or credulous fools. Such denunciations, however, affect us little. The fact that Spiritualism has firmly established itself in our sceptical and materialistic age, that it has continuously grown and developed for nearly forty years, that by mere weight of evidence, and in spite of the most powerful prepossessions, it has compelled recognition by an ever-increasing body of men in all classes of society, and has gained adherents in the highest ranks of science and philosophy, and finally that, despite abuse and misrepresentation, the folly of enthusiasts, and the knavery of impostors, it has rarely failed to convince those who have made a thorough and painstaking investigation, and has never lost a convert thus made; all this affords a conclusive answer to the objections so commonly urged against it. Let us, then, simply ignore the scorn and incredulity of those who really know nothing of the matter, and consider, briefly, what are the actual relations of Science and Spiritualism, and to what extent the latter supplements and illumines the former.

"Science may be defined as knowledge of the universe in which we live,—full and systematised knowledge leading to the discovery of laws and the comprehension of causes. The true student of Science neglects nothing and despises nothing that may widen and deepen his knowledge of Nature, and if he is wise as well as learned he will hesitate before he applies the term 'impossible' to any facts which are widely believed and have been repeatedly observed by men as intelligent and honest as himself. Now, modern Spiritualism rests solely on the observation and comparison of facts in a domain of Nature which has been hitherto little explored, and it is a contradiction in terms to say that such an investigation is opposed to Science. Equally absurd is the allegation that some of the phenomena of Spiritualism 'contradict the laws of Nature,' since there is no law of Nature yet known to us but may be apparently contravened by the action of more recondite laws or forces. Spiritualists observe facts and record experiments, and then construct hypotheses which will best explain and co-ordinate the facts, and in so doing they are pursuing a truly scientific course. They have now collected an enormous body of observations tested and verified in every possible way, and they have determined many of the conditions necessary for the production of the phenomena. They have also arrived at certain general conclusions as to the causes of these phenomena, and they simply refuse to recognise the competence of those who have no acquaintance whatever with the facts to determine the value or correctness of those conclusions."

I must now proceed to examine these contentions. That, like any utterances of Mr. A. R. Wallace, they merit a careful—and even a deferential—consideration it does not need to be urged.

The fundamental initial difficulty which Mr. Wallace, so far as I can see, does not attempt to remove is this:—Science is based upon what we, for want of a better name, term *law*. Spiritualism rests upon *will*. Science—and not merely our present science, but any possible science, so far as I can conceive it—takes its stand upon the causal nexus, upon the regular sequence of cause and effect. Iron always sinks in mercury, and always dissolves in hydrochloric acid; oils and fats, if heated to a sufficient temperature, always burn. No matter in what age, in what corner of the world, or in what climate the experiment is made the result comes out the same. Hence we are able to foretell phenomena. We know that under the same conditions the same results will follow. There are, of course, numbers of cases in which the causes and conditions of phenomena have not been traced out. Here prediction is impossible; but we were gradually going on solving these difficulties, and meantime the power of prevision was recognised as the great distinguishing mark between Science—*i.e.*, organised knowledge—and mere desultory empirical knowledge.

Not only Science, but practical Art, all the doings of daily life, rest upon this same observed invariability. There is, in short, as we have always imagined, law and order in the universe.

Now *will*—finite will at least—is, I submit, the very antithesis of law. Where will—*arbitrium*—comes in, we have of necessity the *arbitrary*. The most of us, indeed ("humbugs" as we might be called for our pains by "advanced thinkers"), have all along recognised one infinite unvarying Will as the ultimate cause of all phenomena. But such Will, being unchangeable and entering at all times equally into all phenomena, occasioned no difficulty. Nor has it been possible to deny that the wills of men and the lower animals—I do not feel certain whether it is safe to add "and of plants also"—were capable of interfering to a limited extent and in certain directions with the order of Nature. But, according to what was considered established in the earlier half of the present century, men and animals could act upon anything outside themselves only where they were personally present, or where there was material physical connection between the agent and the object acted upon. The limits, too, of human or other animal power were supposed to be approximately known.

With the advent of Spiritualism all this beautiful simplicity has been swept away. If Spiritualists are not mistaken there are around us numbers of finite invisible beings, of unknown powers and of unknown intentions, capable of interfering with the order of Nature. They can raise bodies in the air against the force of gravitation. They can kindle fires at pleasure, or deprive fire of the power of destroying organised beings or of occasioning pain. They can hurl stones, break furniture to fragments, convey living persons from a distance, even through walls; they can kill human beings without any visible agency. To me it seems that if these contentions are true, if there exist beings around us capable of exerting such powers, there are introduced, so to speak, into every equation a number of unknown quantities, rendering it for ever insoluble. We can only say "such results will follow under such conditions, if no spirits think proper to interfere." It seems to me that before any harmony can be shown between Spiritualism and Science it must be ascertained what are the limits of the powers of these "spirits," and under what conditions can they be exerted? In that manner only can a basis for Science be saved. If no limits to interference exist, or if none can be traced, then yesterday's experience or observation is no guide for to-day or to-morrow. We are, in short, put to intellectual shame and confusion.

This question has its moral aspect. It will be remembered how Oersted congratulates the modern world on its deliverance from the bondage of the Middle Ages, from the ever-haunting dread of the interference of spirits. He shows how unfavourable was the ethical influence of this system of belief, and how it repressed mental development. He was, it seems, premature: if the "mediums" of the present are merely the witches and sorcerers of the past, and if the "controls" are a modern form of familiar spirits, we are again returning to a "betooverte Wereld"—to a world dominated and overshadowed by the "supernatural." I submit, with all deference, that the refutation of Materialism and Agnosticism is too dear at such a price.

To harmonise Science with Spiritualism it will then be, in the first place, necessary to discover the limits of the power of spirits, under what conditions it is exerted, and how it may be combatted when and where it is undesirable.

The second difficulty is what is inaccurately called the "passage of matter through matter." What is meant is the passage of one solid through another solid without the permanent disintegration of either. Phenomena of this kind are described as happening from time to time at Spiritualist *séances*, the case of the iron ring round a man's wrist being the latest and best known. We fear that many persons who repeat this incident scarcely realise all that it involves. The temporary disintegration, either of a human hand or of an iron ring,—in the former case without loss of blood, without pain, or even consciousness,—followed by the replacement of every molecule as it was before, is a miracle probably surpassing anything recorded in ancient traditions. Had I seen it done I do not hesitate to say that I should have considered that I was suffering from madness, and that in this state I saw what had no objective existence.

We next come to a much more difficult point. It has always been considered that the creation or destruction of energy is, if possible at all, the prerogative of one only Being. But, unless I fail to understand Spiritualist teachings, the "spirits" seem to have the creation of energy in their power. Suppose that a heavy weight is raised up by human instrumentality: if men push it up from below or lift it from above, with the aid of screw-jacks, pulleys, or the like, the motive power is derived from the consumption of certain forms of matter in the bodies of the men who work the machinery, and these forms of matter are again traceable to the heat and light of the sun. Or, if a steam-engine supplies the motive power, we find the source of such power stored up in the coal, and being again merely a result of the sun's action. We have been accustomed to say that no energy can be exerted except at the cost of the transformation of some kind of matter.

But what matter is transformed or converted, in order to yield the energy which is brought into play, when a "spirit" —*i.e.*, an unextended being—raises a massive dining-table up to the ceiling or pulls away the chair from underneath a man? By what agency is the conversion effected? If the ordinary axiom still hold good, that action and reaction are equal and opposite, where is the fulcrum or the point from which the force is exerted? These are questions to which scientific men, "students or teachers," will naturally seek for precise answers before they can accept the Spiritualist theories. They will seek to know whether—and, if so, in what manner—the doctrine of the conservation of energy can be saved or not, and if not, what then? That this last question touches practice no less than theory does not need to be demonstrated. To establish a harmony between Spiritualism and Science it will be necessary, I submit, to show the origin of the energy which is at the disposal of spirits.

I do not see clearly whether or no Spiritualists claim the creation of matter as one of the prerogatives of spirits, and hence on this point I can say nothing.

The great fundamental law of Evolution is accepted by Mr. Wallace in the paper before me, and indeed nothing else could be supposed. Possibly—though I speak with great diffidence—the biologist may find fewer and slighter difficulties in accepting the teachings of Spiritualism than do the physicist and the chemist.

I have still to ask how the principle of continuity fares at the hands of Spiritualism? It seems to me that between man and spirits, of whatever grade, there is a gap not bridged over. The difficulty is greatest if we admit with the Occultists (?), and I believe with some of the Spiritualists, that there exist spirits inferior to man. Whether these are the disembodied spirits of some of the lower animals it does not appear, though I may remark that—both in "Light" and in the "Psychological Review"—I have met with cases of the reappearance of certain domestic animals. For the return of these beings to earth-life the evidence seems of the same kind as that in case of departed human beings.

Mr. Wallace continues:—

"We who have satisfied ourselves of the reality of the phenomena of modern Spiritualism, in all their wide-reaching extent and endless variety, are enabled to look upon the records of the past with new interest and fuller appreciation. It is surely something to be relieved from the necessity of classing Socrates and St. Augustine, Luther and Swedenborg, as the credulous victims of delusion or imposture. The so-called miracles and supernatural events which pervade the sacred books and historical records of all nations find their place among natural phenomena, and need no longer be laboriously explained away. The witchcraft mania of Europe and America affords the materials for an important study, since we are now able to detect the basis of fact on which it rested, and to separate from it the Satanic interpretation which invested it with horror, and appeared to justify the cruel punishments by which it was attempted to be suppressed. Local folk-lore and superstitions acquire a living interest, since they are often based on phenomena which we can reproduce under proper conditions, and the same may be said of much of the sorcery and magic of the Middle Ages. In these and many other ways history and anthropology are illuminated by Spiritualism.

" Science will equally benefit, since it will have opened to it a new domain of surpassing interest. Just as there is behind the visible world of Nature an ' unseen universe ' of forces, the study of which continually opens up fresh worlds of knowledge often intimately connected with the true comprehension of the most familiar phenomena of Nature, so the world of mind will be illuminated by the new facts and principles which the study of Spiritualism makes known to us. Modern science utterly fails to realise the nature of mind or to account for its presence in the universe, except by the mere verbal and unthinkable dogma that it is ' the product of organisation.' Spiritualism, on the other hand, recognises in mind the cause of organisation, and perhaps even of matter itself, and it has added greatly to our knowledge of man's nature by demonstrating the existence of individual minds indistinguishable from those of human beings, yet separate from any human body. It has made us acquainted with forms of matter of which materialistic science has no cognisance, and with an ethereal chemistry whose transformations are far more marvellous than any of those with which Science deals. It thus gives us proof that there are possibilities of organised existence beyond those of the material world, and in so doing removes the greatest stumbling-block in the way of belief in a future state of existence—the possibility so often felt by the student of material science of separating the conscious mind from its partnership with the brain and nervous system.

" On the spiritual [Spiritualist] theory man consists essentially of a spiritual nature and mind intimately associated with a spiritual body or soul, both of which are developed in and by means of a material organism. Thus the whole *raison d'être* of the material universe—with all its marvellous changes and adaptations, the infinite complexity of matter and of the ethereal forces which pervade and vivify it, the vast wealth of Nature in the animal and vegetable kingdoms—is to serve the grand purpose of developing human spirits in human bodies."

This last passage calls for a few remarks. My estimate of the visions of Swedenborg is founded on the fact that whilst he could furnish descriptions of planets known in his time, such as Jupiter or Saturn, he gives no hint of the existence of Uranus and Neptune, which were then unknown to astronomers. Had he done so his visions would have been completely freed from the stain of delusion or imposture.

Upon witchcraft Spiritualism has thrown a new and unexpected light. If it was, as was generally held in the first half of this century, a mere delusion, then the punishments by which it was suppressed were gratuitous atrocities; but if the witches had really the powers attributed to them in the fifteenth, sixteenth, and seventeenth centuries,—if they could really blight corn, afflict man and beast with disease, pestilence, and death, or if they served as "mediums" for malignant spirits,—then their extirpation was not merely a duty, but a necessity, though the painful task unfortunately was carried out with needless cruelty.

VI. THE HEREDITARY TRANSMISSION OF STATURE TO FEMALE DESCENDANTS IN HORSES, AND THE FACTORS WHICH DETERMINE SEX.

DRS. SCHLECHTER and DÜSING have made certain interesting observations on these subjects, which are recorded in "Koch's Revue für Thierheilkunde," in the "Deutsch. Zeitschrift für Thiermedicin," and in the "Jena Zeitschrift für Naturwissenschaft."

The following are their principal conclusions:—

1. The average size of female progeny in horses—without reference to the crossing of different races—approximates more to the average stature of the mother than to that of the father.
2. Even abstracting from an average heredity of size, the stature of the female offspring is, in individual cases, nearer that of the mother than that of the father.

3. In those cases in which the stature of the father far exceeds that of the mother, the female descendants will be larger than the mother, but smaller if the father is only little larger than the mother, of equal size, or smaller.
4. The mean size of the female offspring of two parents of equal stature, whether of the same race or of different races, is generally a little smaller than that of the parents. The reason is that in those cases in which the female offspring exceeds the stature of of its parents, the difference is smaller than when it falls below them. The number of cases, however, in which the female descendant respectively surpasses or falls short of the stature of the parents is approximately equal.
5. When the size of female descendants is determined by the father, this happens most commonly in crossings in which the father belongs to the English blood or half-blood race. In all other races which have come under our observations no especial influence is perceptible, but it is perfectly indifferent to which race the father or the mother belongs.
6. In crossing English blood stallions with Arabian mares the female offspring produced almost exclusively exceeds the mean stature of the parents. On crossing the same stallions with Norman mares the reverse is the case.
7. In all the above-mentioned points exceptions are not rare, so that no simple rule can be given for predicting the stature of female posterity in horses.

As regards the factors which determine sex, Düsing lays down the following conclusions:—

Fiquet had observed in cattle the fact that animals whose sexual powers are called into more frequent requisition produce more individuals of their own sex. Düsing ascribes this result to the circumstance that in males in such cases the semen secreted comes quickly into requisition, and fecundation is therefore effected by means of relatively young spermatozoa.

Hence more male young are produced, whilst a sexually inactive male begets more female young, on account of the greater age of the spermatozoa. It follows that the greater the want of individuals of one sex, the greater demand is made upon those already existing, the more rapidly their sexual products are used up, and the more individuals of the same sex are produced, thus restoring the balance. Want of nutriment has the same effect as sexual overwork. Weak bulls with powerful cows produce chiefly bull-calves; weak cows with strong bulls drop more cow-calves.

As for age, each individual at the time of its greatest sexual capacity is *least* disposed to impart its own sex to its descendants. In the human species the excess of boys is therefore greatest when the husband is considerably older than the wife. Düsing is therefore of opinion that animals have acquired the power of adaptation to produce more individuals of the sex which is in a temporary minority.

When food is present in abundance more females are born; in times of scarcity more males, because the chief burden of reproduction devolves upon the female.

Düsing draws the following conclusions from observations on the lower animals: the sexual proportion is self-regulating. That sex is produced more abundantly whose increase is at the time being the more advantageous for the preservation of the species. Such conclusions are not to be accepted without caution.

VII. TESTING FOR COLOUR-BLINDNESS IN THE MERCANTILE MARINE.

By Jabez Hogg, M.R.C.S., F.R.M.S., &c.,
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IN a former paper, " Homer Colour-blind," I very slightly touched upon the wider question,—one which possesses interest for most people,—colour-blindness, as affecting mankind in general and the mercantile marine in particular. Although the investigation of this remarkable phenomenon brought to light a curious fact, that on an average one male out of every twenty-five is quite unable to discriminate the principal colours of the spectrum, it excited no great deal of attention until it became apparent that, both on our iron-roadways and on the ocean, deplorable accidents were likely to—and often did—occur, from the colour-blindness of drivers and guards of railway trains, and of masters and pilots in charge of ships. It was at length fairly demonstrated that a certain percentage of persons employed on the railways, and in the Mercantile Marine Service, were, without being aware of it, unable to discriminate between the red and green signal colours in common use. Those who now offer themselves for employment on railways are, and have been for some years, subjected to a compulsory examination in colours, so that there no longer need be fear on this account. But as to the Mercantile Marine, the evidence adduced before the Royal Commission on Shipping, now sitting, shows that the loss of life and property at sea has in no way diminished, has in truth materially increased, during the last ten years, out of all proportion to the increase of shipping, and it is alleged that a number of the collisions that annually occur is due to the colour-blindness of the navigating officer or the pilot in charge.

The Board of Trade, eight years ago, came to the decision—because of the serious consequences involved in the question of colour-blindness—that all masters and mates should undergo a test-examination in the following colours, *viz.*, red, green, blue, yellow, black, and white, before proceeding to an examination for a certificate of a higher grade. During the first two years, between May, 1877 and 1879, no less than 39 candidates failed to obtain certificates on account of their defective colour-sense. From this number twelve should be deducted, who were subsequently reported to have satisfied the examiners on a re-examination, leaving the actual number of failures from colour-blindness at 26.

After 1880 the result of failure to pass the colour-test was made equivalent to that of failure to pass the ordinary examination in navigation and seamanship,—that is, it prevented a considerable number of candidates from obtaining the certificates for which they applied.

The value of the colour-test soon became manifest to those in authority, and thereupon the Board of Trade, in February, 1880, after bringing their views to the attention of the Local Marine Boards, and receiving the concurrence of the majority of those Boards, resolved to extend the colour-test examination to all about to serve in the Mercantile Marine, and make it compulsory upon masters and mates to submit to the test. Consequently since March, 1880, all officers who for the first time applied for certificates of competency, in any grade, have been subjected to a colour-test examination, and if they failed in this they were not permitted to present themselves for the further examinations in navigation and in seamanship. In the event, however, of either a mate or master having already received a certificate of a lower grade, and presenting himself for one of a higher grade, and then failing to satisfy the examiner of his ability to distinguish colours, the higher grade certificate has been granted, with a statement written across it that "the holder has failed to pass the examination in colours." This has, no doubt, in individual cases operated prejudicially; it has prevented incompetent mates or masters from obtaining employment, but it is only right and just that shipowners should be in a position to protect themselves. No case of hardship has, however, come to the knowledge of the Board: furthermore, to guard against injustice or a hasty judgment on the part of the examiner, a candidate may, on the expiration of three months from his first examination, apply to be re-examined for a second and third time, and by a later order he can obtain the permission of the Board of Trade to be again tested in colours for the fourth and last time.

By the extension of the colour-test to all persons, any man or boy about to enter the Mercantile Marine can satisfy himself and his friends of his ability to distinguish the colours of the flags and lights in use on board ship. These optional examinations have also been the means of preventing those who are unable to name colours from taking to the sea at all as a means of livelihood.

It is a matter of considerable regret that the colour-test has not been made obligatory upon pilots and men on the "look out," as well as upon masters and mates. Pilots claim the right to navigate all ships as soon as they near our coasts, and it is of the very gravest importance that they should make no mistake as to the lights displayed by other ships. This omission is entirely owing to a divided authority, the pilot service being exclusively under the control of the Trinity House, a body alleged to be somewhat addicted to placing obstacles in the way of scientific progress.

The mode of conducting the colour-test examination is of a threefold nature—by coloured cards, wools, and glasses. The examiners are supplied with selected boxes of each of these, and the examination commences with the cards, the most important daylight test being red, green, and black: if the candidate is able to distinguish and name the colour of each it is sufficient, and he obtains his certificate. The standard red and green glasses are of the same colours as the "port" and "starboard" lights of a ship, and these are used in a darkened room, a lamp being placed behind them. The testing by coloured glasses follows that of cards or skeins of wool, special attention being paid to the candidate's ability to distinguish the red from the green glass. The examination on the whole is made with a view of determining whether a candidate can distinguish signals by day,—as flags, which are composed of many colours,—and next whether he can distinguish signals by night,—the lamps carried by ships, which are either red, green, or white. If, therefore, a man can distinguish red from green, and both from white or black, the examiner considers that he will be able to follow the International Rules for the prevention of collisions at sea. This method of testing has, we are told, been found sufficient for the purpose for which it is applied, "that purpose being not to discover and record the peculiarities of sight of the applicant, nor his powers of detecting and arranging all colours and tints, but to test his ability to name a common well-known colour when it is placed before him."

Candidates can hardly be expected to complain of the easy-going method sanctioned by the Board of Trade. Nevertheless it will occur to members of the medical profession that it is capable of a good deal of improvement. First, to be thoroughly effective the examination should undoubtedly be made more practical,—that is, quite in accord with the conditions under which the recognition of coloured signals at sea will usually take place. Second, the examiners should, for obvious reasons, be trained men, well acquainted with the subject, and not retired ship-captains. With examinations more intelligently conducted than at present, it could hardly happen that so large a proportion of the candidates who on their first examination called green red, and red green, would upon re-examination obtain certificates.

The Board of Trade, however, with every desire to do its best, in 1881 endeavoured to ascertain the practice adopted by other nations, and a circular was issued to the principal powers of Europe, as well as to America. From the answers we gather that a colour-test has been in use in the United States for some years. In the case of pilots applying for the renewal of their licenses, or of applicants for original licenses as pilots on steam-vessels, examination is compulsory, and since 1880 a voluntary examination for all persons serving in the Mercantile Marine, as to physical fitness and ability to distinguish colour, has existed.

In the voluntary examination, the system known as "Holmgren's worsted test" is used; and the medical specialists who conduct them say that it has proved fairly satisfactory. With regard to European countries, Austria and the Netherlands are the only nations that have introduced a colour-test examination into their mercantile marine services, while France and four other nations have introduced a colour-test into their naval schools and State navies only. Belgium has instituted a compulsory examination for *employés* in mail-boats running between Dover and Ostend. Holmgren's method is used, and, in addition, all Antwerp pilots are examined by two ships' lights, red and green, presented at 10 metres distance from the candidate; the position of the lights being changed rapidly. Flushing pilots are examined by means of different shades of colour thrown upon a black background: while Ostend pilots have a number of pieces of wall-paper, or skeins of wool, of different shades of colour placed before them, and these they are required to group into the colours of the spectrum, a copy of which is placed before them.

Duly considering the various modes of conducting the examination practised by other nations, the Board of Trade came to the conclusion "that there was nothing in the colour-tests, or mode of applying them, as adopted by other countries, which, for practical purposes, is an improvement upon those in use in this country." But while it is thought to be undesirable to make any alteration in the mode of applying the colour-test in this country, it is admitted to be necessary to apply it more generally, and that "an examination in colours is needed, not only for officers, but for pilots and men on the 'look out.'" This will scarcely be made compulsory on all alike so long as shipowners affect to despise, or disbelieve in, the dangers arising from colour-blindness. An ignorant determination to reject all proofs on this score bars the way to the adoption of preventive measures.

As to the results of the past four years' examinations, from May, 1880, to May, 1884, when the colour-test was made compulsory, a great many curious mistakes, it appears, were made in colours by the 85 candidates who presented themselves for certificates: not all of whom were rejected, for 29 applied to be re-examined, and ultimately succeeded in satisfying the examiners. It should be observed, however, that the greater part of them were re-examined in provincial towns, and were said to be able to distinguish between red and green. Beside these 85 failures, there were also

55 failures reported in examinations for colours only. This, I assume, implies that a number of persons voluntarily offered themselves for the colour-test certificate before going to sea, and paid their shillings to satisfy themselves of their inability to distinguish colours commonly in use.

Many typical cases of complete and incomplete colour-blindness are given, and the subjoined summary more clearly shows the particular mistakes made by the 85 candidates already referred to.

Colours of cards or glasses.		Green.	Red.	Yellow.	Blue.	Other colours.
Green	described as	—	79	16	13	13
Red	,,	24	—	3	3	3
Yellow	,,	9	38	—	1	2
Blue	,,	45	2	1	—	4
Black	,,	4	2	—	—	3
White	,,	3	1	—	—	—

Since the report does not state the total number of persons examined within the year, or the past four years, I am unable to give the exact percentage of rejections; but it may be assumed that it does not greatly differ from that of 1877 and 1878, which was rather under ½ per cent. It is believed that last year it stood rather higher, 0·56 per cent.

The hereditary nature of colour-blindness is a curious feature in the case. It is apparently known to but comparatively few persons that colour-blindness is transmissible, affects the human race in different degrees, is an incurable physical affection, and remarkable enough is chiefly confined to the male branch of families. A select instance or two from among many will serve to impress the first feature on the memory. In a family of seven children, four sons and three daughters, the sons are more or less colour-blind. The defect in this case is inherited from the grandfather, through the mother, whose vision, as also that of her three daughters, is quite normal. In another family of five children, three sons and two daughters, the sons inherit the colour-blindness of their father and grandfather, while the two daughters, and, indeed, all the females, for three generations at least, have been free from any colour defect.

My reason for referring to the hereditary nature of colour-blindness is that I wish more particularly to enforce a duty upon parents, one they owe to themselves and their children, that of making due inquiry into every peculiarity or defect of vision which may have constituted a family failing, before yielding to the wish of a son for a sea-faring life. The inability of a boy to distinguish colours commonly in use should at once settle the question of his taking to the sea at all.

Colour-blindness is, to some extent, aggravated by age, just as is the case with certain other defects of vision. It apparently may be developed in after life, and as the near point of vision recedes. The Academy at this moment furnishes abundant examples, and which seem to justify the criticism that "yards of garish canvasses wanting in ideas, composition, drawing, and colour" cover its walls. To what other cause, if not to a great deterioration of the colour-sense, or to colour-blindness, can this great falling off in the works of artists be attributed?

As to the physical nature of colour-blindness, no entirely satisfactory explanation has been offered. Hering advanced a plausible theory that colour is the mental perception of the changes taking place in the visual substance, which, under the influence of light, is constantly undergoing a double process of disintegration and reparation. Perception of white light being coincident with disintegration; of blackness with re-integration; the degrees of white and black depending on the activity of the processes of disintegration and repair. But of the many theories promulgated, that known as the Young-Helmholtz is regarded as the most acceptable. According to this theory, the retina has three kinds of colour-perceiving elements, the stimulation of which gives respectively the sensation of red, green, and violet. White light excites all the elements equally, but if monochromatic or homogeneous light be received upon the retina, then each of the three kinds of fibres are simultaneously stimulated, and with an intensity that varies with the length of the waves. Thus, red light, which has waves of the greatest length, stimulates the red elements strongly, the green more feebly, and the violet only slightly, consequently the sensation experienced is red. Green, which has waves of intermediate length, stimulates the red and the violet feebly, and the green elements strongly, and the sensation perceived is green, and so with the violet, which has waves of the shortest length, and which acts as a powerful stimulus to the violet elements of the retina, and scarcely affects the green and red elements at all.

From what I have stated it may be understood that there are three kinds of colour-blindness corresponding to the three colour-perceiving elements: red blindness, green blindness, and blue or violet blindness. Of the several layers of which the retina is made up, it is the layer of rods and cones that is concerned in the production of light and colour. Schultz believes that they both serve as elements of light, although the perception of light is the more immediate function of the rods, while that of colour exclusively belongs to the cones; should these be congenitally absent or partly developed it follows that the retina, and consequently the eye, must be insensible to certain portions of the spectrum colour-blind.

The physical and physiological bearings of the colour sense are too vast and important to be disposed of within a brief space; I must therefore content myself by stating for the present that the range of human vision, like that of hearing, is subject to great variations in different individuals, and that a great disproportion exists between the actual number of natural colours and the limited amount of sensory colours. The conclusion to be drawn from this observation is, that, "normally every visual mechanism is physically and physiologically fitted to respond to but a small number of the great bulk of natural colour vibrations, and thus virtually proving that every such mechanism is truly colour-blind."—(*Oliver*). It has been said of Chevreul that he was able to distinguish 14,420 tones of colour; more recently, too, it has been found that the human eye is totally unable to receive all the vibrations of colour which must exist in the spectrum. We know that it does not recognise the terminals of either end—the red and violet—and how many unrecognised natural colour differences actually exist between the red and the violet ends of the ordinary spectrum. Through the want of power of perception in the retina it is quite impossible to say or imagine.—(*Oliver*).

VIII. ON THE HUMAN TAIL.

ANTI-EVOLUTIONIST writers, who, as a rule, are not biologists, still concern themselves about man's supposed want of a tail. They have, indeed, been repeatedly told that the anthropoid apes are in this respect exactly on a level with man. If they were sincerely anxious for the the truth they might easily convince themselves that this is the fact, and that the tail vanishes from the animal series before we reach that mythological "great gulf" which is supposed to separate beast from man. Yet they are not satisfied, and still persist, as in particular does the author of a work recently noticed in the "Journal of Science," in entangling themselves with this appendage.

Hence it may be useful if we lay before our readers some researches which M. H. Fol has recently submitted to the French Academy of Sciences. He asks, does the human embryo ever present at the posterior extremity of its body anything which merits the name of *tail*? This question must give rise to a discussion which cannot fail to be lively, unless we have previously made the necessary distinctions and have come to an understsnding on the strict definition of the terms employed.

It is necessary at the outset to distinguish teratological cases from the far more important phenomena of normal embryogeny which are about to engage our attention. Then we must agree as to the meaning of the word *tail*. Is this term applicable to every conical or cylindro-conical appendage at the posterior extremity of the back, whatever may be the tissues of which it is composed? Or should it be reserved for an organ containing a prolongation of the vertebral column? This latter definition seems to preponderate. An appendage devoid of vertebræ is not a true tail in the anatomical sense of the term, but merely a simple caudal prolongation.

In the monstrosities described by L. Gerlach, Bartels, and Ornstein, the appendage, whether filiform or voluminous, did not contain any evident undeniable vertebræ, and the total number of these bony structures did not exceed the regular number of a normal man.

As regards young embryos, an understanding is not possible if we do not first determine the point where the caudal vertebræ begin. Shall we fix the limit at the point where the tail branches off from the body? Or are we to be guided by the position of the anus? Or must we give the name caudal to all the vertebræ situate behind the sacrum? This last-mentioned view has prevailed in comparative anatomy, and from this point of view we may say that the adult man possesses a tail, since he presents four or five coccygian vertebræ, situate beyond the sacrum. The minimum, in this respect, is reached by the chimpanzee, which has only two or three coccygian vertebræ. This ape is consequently, when mature, further from possessing an externally visible tail than is the normal adult man—a fact not without significance.

If we apply the name of tail to the portion of the vertebral column which is situate outside the trunk of the body, it must be admitted that from the age of three weeks to that of two months and upwards the human embryo is endowed with this organ, for at this epoch the coccygial vertebræ occupy the axis of a cylindro-conical appendage, which is very apparent, and which issues from the posterior extremity of the trunk. If with His we take the position of the anus for a guide the tail will be less long, but is still very conspicuous, especially at the age of five to six weeks.

But it is generally admitted as absolutely demonstrated that this caudal appendage of the human embryo never contains any other vertebræ than those found in the coccyx of the adult. Ecker, who gives, in full conviction, the name of tail to the posterior extremity of the human embryo, has declared that he has never met with any supernumerary vertebræ. This author has even studied the well-developed tail of a human embryo 9 millimetres in length, and he describes and figures all the terminal part as consisting of an amorphous blasteme. His, however, detects here a prolongation of the dorsal cord and of the spinal marrow, but no segmentation. Both these authorities admit that beyond the 33rd or 34th vertebræ there is no further portion of the skeleton.

On this point the researches of M. Fol have led him to a result diametrically opposite to that of his predecessors. The error of His is due to the circumstance that the oldest embryos which he has examined, those of 7 millimetres have exactly 34 myomeres, that is to say 33 vertebræ; and he admits, without any further proof, that this was their ultimate condition.

M. Fol presented to the Academy a summary of his anatomical study of a human embryo of 5·6 millimetres, *i.e.*, of 25 days old. This embryo had as yet only 33 somites, representing 32 vertebræ. There is, therefore, an increase in number in the fourth week. This fact led M. Fol to examine if the number did not go on increasing during the fifth week, and his expectation was not disappointed. The human embryo of from 9 to 10 millimetres, the age when the tail attains its greatest prominence, possesses a *greater number of vertebræ than the adult.*

Two embryos of the finest appearance, and perfectly fresh when sent to the author, were first photograped and then cut into sections. The series of slices are irreproachable, and one of the two, comprising 320 sections, has been most carefully drawn in the camera lucida, in its totality. On comparing these 320 figures it is easy to count, without any chance of error,—1, the rachidian ganglia; 2, the myomeres; 3, the nascent cartilages of the bodies of the vertebræ. These three enumerations check and confirm each other, since they all three give the same result: *the human embryo of eight to nine millimetres has thirty-eight vertebræ.*

This result is further confirmed by an examination of the photographs of the recent parts, since we readily distinguish 35 myomeres, and besides a region occupying the external fourth part of the tail where the demarcations are no longer visible through the skin. But the sections show us that in this last quarter, contrary to the opinion of Ecker and His, the mesoderm is most distinctly divided into a double range of somites extending to the very tip of the tail, presenting dimensions regularly decreasing to the 38th somite, which measures merely 37 micromillimetres in diameter.

This fact is not teratological; it is fully confirmed by various other embryos which I possess, all perfectly normal, but slightly differing in age.

With the exception of the last two all the caudal vertebræ have a blasteme of cartilaginous substance, similar, except in size, to that of every other vertebra of the series. The last two are only indicated by myomeres, perfectly distinct from the rest. The extremity of the tail is formed by the termination of the medullary tube, covered merely by the skin. The dorsal cord extends, therefore, quite close to this extremity.

The last caudal vertebræ have but a very ephemeral existence. Already in embryos of 12 millimetres,—that is to say, of six weeks,—the 38th, 37th, and 36th vertebræ are blended together into a single mass, and the 35th itself has no longer very distinct limits. An embryo of 19 millimetres has merely 34 vertebræ, the 34th resulting from the fusion of the four last. At this moment the tail altogether is already much less prominent.

It results from these facts that the human embryo during the fifth and sixth week of its development is furnished with an incontestable tail, regularly conical, elongated, and deserving the name in all respects. It is deprived of all physiological utility, and must rank among the rudimentary organs.

ANALYSES OF BOOKS.

Elementary Text-Book of Entomology. By W. F. Kirby, Assistant in Zoological Department, British Museum, and Co-Secretary to the Entomological Society of London. London: W. Swan Sonnenschein and Co.

We have here a work which in some respects takes up ground not yet unoccupied. Accessible books on Entomology are for the most part devoted to some particular group of insects, or to the species inhabiting some particular country. Mr. Kirby describes all the groups of insects of the entire world. It is more systematic than the twin volumes by the Rev. J. G. Wood, "Insects at Home" and "Insects Abroad," freer from irrelevant reflections, and from the initial error of putting the insects of Britain—a group founded on a mixture of considerations, partly geographical and partly political—in antithesis to those of all the rest of the world.

The author in his classification recognises the seven "orders," as they are commonly called, Coleoptera, Orthoptera, Neuroptera, Hymenoptera, Lepidoptera, Hemiptera, and Diptera. He consequently rejects the separation of the earwigs from the Orthoptera as a distinct order (Euplexoptera); he includes the suggested order Strepsiptera among the Coleoptera; he assigns to the Heteroptera and Homoptera a subordinate rank as divisions of Hemiptera. He does not accept the strange proposal to form the Orthoptera together with the bulk of the Neuroptera into a new order, Pseudoneuroptera.

Mr. Kirby, however, is no believer in linear classifications. Indeed, as an Evolutionist, he regards every classification as merely provisional and approximate. He writes:—"Organic nature is now believed to have grown up into the form in which we see it from infinitesimal beginnings, by the effect of gradual changes acting and reacting on each other in the course of countless ages. We have consequently nothing before us to classify but the extreme ends of a vast tree, of the rest of which we are scarcely able to catch even the slightest glimpse. Consequently, while every group and every species is more or less related to others, a book arrangement can only be linear, and while it expresses a certain amount of affinity between the groups and species placed in juxtaposition, it likewise tends to conceal the fact that equally important affinities frequently exist between other species or groups which may chance to be widely separated in our necessarily artificial arrangements."

We have been disposed to quote the above passage not as containing any absolutely novel conception, but as being fairly representative of the manner in which the organic world appears to those who are constantly in the habit of studying it, not in books, but face to face; unless indeed they are blinded by early prepossessions and *à priori* notions,—fragments of the official mantle of Cuvier, which remaineth upon the eyes of the "Section of Zoology and Anatomy" of that most bureaucratic body, the French Academy of Sciences.

The following passage may be commended to the many who seem to mistake the scope of Entomology:—"The collector's province may be exhausted in a few years; but the observers, never."

From the immense extent of the subject it has been, of course, impossible for the author to describe every species, or even every genus. He has been compelled to restrict himself in every family to the most characteristic forms. We note that in his arrangement of beetles he places the Brachelytra not as is done, *e.g.*, by Stephens, at the end of the order, but next after the Palpicornia. A well-known carrion beetle, lately known as *Oiceptoma thoracica*, is restored to the original genus *Silpha*. The genus *Typhœus*, however, is retained for the black three-horned dung-beetle of Epping Forest. The locality given for *Purpuricenus Kœhleri* is "as far north as the southern slopes of the Alps." These limits require extending; two specimens in our possession we captured near Neuwied, on the Rhine.

When speaking of the earwig, Mr. Kirby tells us that he has heard of perfectly trustworthy cases in which this insect has entered the human ear.

Among the exotic species of insects which have succeeded in becoming acclimatised in England is the little yellow Brazilian ant, *Diplorhoptrum molestum*. Its introduction does not seem to date back beyond the present century. This fact gives a certain weight to Mr. Kirby's caution that certain species of Termites may possibly naturalise themselves in our midst.

The illustrations to this work are numerous, and, although not coloured, are well fitted for their purpose. There has been no attempt to make them into ornaments. In our opinion Mr. Kirby has executed his task—evidently a labour of love—in a very satisfactory manner.

Notes on the Meteorology of the South Australian Alps. By JAMES STIRLING, F.L.S.

THIS memoir, which is a reprint from the "Transactions of the Royal Society of Victoria," has been courteously forwarded to us by the author. It contains a series of observations made at Omeo, and is a very useful contribution to the meteorology not merely of Australia, but generally of the Southern Hemisphere,—a subject in great need of more extended study.

Mr. Stirling began his observations in 1879 at Omeo. The exact altitude of this place does not seem to be given, though we should conclude from various data that it is more than 2000 feet above the sea-level. He has also collected returns from settlers living in the mountainous region around, and has erected instruments at Mount St. Bernard, at the elevation of 5036 feet. Mr. Boustead is in charge of this latter station. We learn that snow falls at heights exceeding 2000 feet. Wheat can be successively cultivated at elevations between 2500 and 3000 feet; and cabbages, green peas, and other esculent vegetables, up to 5000 feet. The author considers that these higher regions of Australia offer a splendid field for investigating many interesting meteorological changes. He suggests the establishment of a chain of high-level observatories from the Western Australian ranges across South Australia, and the summits of the Australian Alps to the Blue Mountains in New South Wales.

The average rainfall at Omeo is 24·18 inches yearly. The average number of wet days in the year is 96, the maximum being 114, the minimum 84. The greatest mean rainfall for any month is in October, 3·47 inches. The moisture-laden winds are the south-westerly and north-westerly. The average annual snowfall at Omeo is 2 feet 3 inches, and at Mount St. Bernard (5000 feet) 14 feet. Near the summit of Mount Kosciusko (7200 feet) it is probably 50 feet. Hail is frequent during summer and autumn in the higher regions, but less common at the sub-alpine altitudes, though the size of the hailstones is often larger, between 2000 and 4000 feet, than at greater heights.

The yearly average of cloudiness, judging from observations made at 9 a.m. daily, is—clear days, 123·4; cloudy, 184·8; and overcast, 55·8. The clear days are, however, in the majority during the summer. It is, we think, by the way, a mistake for meteorologists to divide the year into four equal seasons. The respective length of the seasons is a phenomenon depending upon latitude, altitude, proximity to the ocean, &c. Now, as in Omeo there are on the average seventeen frosty days yearly, which may occur from May to September inclusive, we should be inclined to say that Omeo has five months winter. July, answering to our December, is the most inclement month, having a minimum temperature of 19° F. The mean annual is 53° 34′ F., or better by about 4° than that of the South of England. The maximum heat registered at Omeo is 105° F., so that the absolute range is 86°. By some clerical or typographical error it is made 128°. Here, as in the United States and in England, it has been observed that exotic plants often flourish on the ridges whilst perishing in the valleys, to which the cold air flows down.

At Omeo it would seem that spontaneous evaporation is in excess of rainfall.

The author—as well as Mr. Griffiths, and subsequently Dr. Von Lendenfeld—has detected evidence of a Glacial epoch in the colony of Victoria, probably in the Post-Miocene. On this subject the author announces a paper, which we hope to have the pleasure of noticing.

On the Mechanical Characters of Lightning Strokes. By Col. the Hon. Arthur Parnell, late Royal Engineers.

In this pamphlet, the reprint of a memoir read before the Royal Meteorological Society, and inserted in their "Quarterly Journal" for January, 1855, the author argues from facts that physical force, as manifested in mechanical work, is a principal characteristic of lightning strokes. Indeed, as far as his own observations and the evidence which he has collected go, mechanical work is their main effect. It would appear that the more powerful the stroke, the less heat effect is produced. The cases tabulated show 1221 instances of mechanical work as against only 485 of heat work. Col. Parnell conceives of lightning as "a luminous manifestion of the explosion caused by two equal forces springing towards each other simultaneously from the earth and the under surface of the inducing cloud, and coalescing or dying out nearly midway between the two plates of the electrical condenser formed by the earth and the cloud." He also holds, upon the strength of a number of observations, that ' of these two forces it is the "earth-sprung or upward force alone which injures persons, buildings, or other objects on the Earth's surface, and which constitutes tangibly what is rightly known as a lightning-stroke."

It is certainly, on the commonly-received view of lightning-strokes as coming from above, remarkable that history presents so few cases where the injury must necessarily have been inflicted, and so many where the force must almost beyond doubt have acted from beneath. It is much to be desired that, in future cases of lightning-stroke, the nature of the damage done should be more carefully examined than has been hitherto generally done.

We remember, long ago, going to inspect a cottage near the Droylsden Copperas Works, Manchester, which had been wrecked by lightning in a very complicated manner. We can distinctly call to mind our being very much puzzled to trace the course of the flash, assuming that it must have come from above, since the damage appeared to be subdivided in passing from the floor towards the roof. Once, when weather-bound at a country inn, we took up, to pass the time, a novel by G. P. R. James, in which a terrible storm is described in which the strokes ascend. The author, as far as we recollect, stated in a note, or in his Preface, that the possibility of such an occurrence having been questioned he had referred the matter to an eminent physicist,—we believe Sir David Brewster,—who, in reply, stated that upward lightning-strokes were by no means unprecedented.

On the Origin and Reproduction of Animal and Vegetable Life on our Globe. By Thomas Spencer, F.C.S., F.R.M.S., &c. London: Effingham Wilson.

Mr. Spencer, we believe, is an inventor and discoverer whom for some occult reason the world has thrust aside, giving the credit of his results, as regards the purification of water, to another. In connection with electro-metallurgy, of which he was our pioneer, his name is now rarely, if ever, mentioned. He seems to share the fate of Dr. Walker in the matter of sanitary reform, and of Thomas Grey as concerns railways. The treatise before us does not, however, deal with these subjects. Its object is to show the action of magnetic iron-oxide in effecting the combination of oxygen with carbon at common temperatures, in presence of moisture. His observations have further rendered it extremely probable that this oxide exists in every reproductive germ, animal or vegetable, and exists, too, in a state of the highest activity. At least, as Mr. Spencer informs us, he has in twenty years' search never failed to find in seed germs iron-oxide in combination with water. Even the soil, he shows, in the absence of iron-oxide is sterile. In demonstration he recommends the attempt to grow seeds in a soil carefully freed from oxide of iron, as compared with a similar soil containing iron. Mr. Spencer contends that the leaves of plants do not absorb aërial carbonic acid, but only sufficient oxygen for its formation. But whence, then, comes the oxygen which they give off? He states that if a healthy growing plant is put in an atmosphere of carbonic acid it dies. But does it not perish also if carbonic acid is entirely excluded?

In the formation of carbonic acid in this manner, heat and electricity are, according to the author, always liberated, and without them life-force would be wanting.

Mr. Spencer pronounces magnetic oxide as the only body in nature "that possesses a *quasi* principle of motion of which it cannot be deprived without chemical dissolution. It is also in itself the most fixed oxide in Nature, though its particles are the most volatile known and ever in imperceptible motion."

Comparative Vocabularies of the Indian Tribes of British Columbia. By W. FRASER TOLMIE and G. M. DAWSON. Montreal: Dawson Bros.

THIS compilation is issued under the auspices of the Geological and Natural History Survey of Canada, and is illustrated with a map showing the distribution of the tribes concerned, who occupy a territory of about 200,000 square miles to the west of the Rocky Mountains. A singular fact is noted in the Preface. Along the coast line there is a striking diversity of languages, which is somewhat puzzling among tribes maritime in their habits, skilled in navigation, and thus enjoying great facilities for mutual intercourse. In the interior of the country, on the contrary, where, from the rugged and densely wooded character of the region, intercommunication is comparatively difficult, the languages have a much wider extent.

Records of the Geological Survey of India. Vol. XVIII., Part 2. 1885.

THIS issue contains some important matter. Mr. R. Lydekker, F.G.S., establishes a second species of fossil camel (*Camelus antiquus*) from the Siwaliks. It is distinguished from *C. Sivalensis* by its smaller size, the perfectly smooth enamel of the teeth, and the concave surface of the lower true molars, the upper half of which is divided into two equal portions by a median vertical ridge, which is totally wanting in *C. Sivalensis* and in the existing camels.

Col. C. A. McMahon, F.G.S., contributes Notes on the Geology of Chambra. He produces evidence that the Himalayas have been slowly rising, whilst the rivers have been deepening their channels. Thus there is no necessity for assuming that the River Siul ever flowed at the elevation at which the boulder-bed now rests. Such boulders now lie at the top of the Chandon Namo Pass, at the height of 12,340 feet above the sea-level and 2400 feet above the present bed of the Spiti.

The flora of these regions is not uninteresting. A poppy of a delicate purple-blue merging into white is common above the zone of trees, but the author has never observed it at lower elevations than 11,000 feet. Wild rhubarb abounds at the head of the valleys. The stalks are consumed by English explorers and sportsmen, but whether the root is pharmaceutically valuable we do not learn. There are many species of Fungi growing on the trunks of trees. According to the natives all the Fungi parasitical on the oak are wholesome, whilst those growing on pine trees are to be avoided. Col. McMahon made a dietetic experiment with one of the former, which he found not unpalatable. He adds :—" On opening my eyes next morning I was thankful to find myself still in the land of the living."

The inhabitants of these upland regions are not believers in cleanliness. The author writes :—" The process of washing my face and hands in the morning was a source of great delight to a group of village maidens, who in these mountain villages seem wholly unacquainted with the cleansing properties of soap and water." The geologist in the Himalayas has to contend with difficulties. Here is a specimen :—" The torrent under Budra has cut a deep narrow gorge through the mountain ; descent to the water's edge was impossible, and the only way to cross the stream was by a frail bridge stretched from rock to rock some 150 or 200 feet above the roaring torrent below. The bridge was formed of these poles about 30 yards in length, and across them small roughly hewn planks were fastened with twigs, forming a roadway of about a yard in width. A plank was dangling by one end over the chasm below, leaving a gap in the roadway, and suggesting painful doubts regarding the stability of the rest of the structure. The bridge had neither railing nor hand-ropes."

Mr. R. D. Oldham discusses the probability of obtaining water by means of Artesian Wells in the plains of Upper India, and comes to the conclusion that there is no zone of coarse permeable deposits continuous with those of the *bhatar*, and that in consequence there is little prospect of obtaining water in this manner in the plains of Upper India, except in small quantities.

Mr. H. B. Medlicott replies, considering the difficulty raised by Mr. Oldham rather imaginary, and re-affirming his conviction that there is a reasonable prospect of success. He urges that the trials hitherto made have been fixed upon solely on grounds of local need, and not as being in any degree favourable sites for testing the conditions.

Mr. F. R. Mallet examines the prevailing opinion that the

Arakán Mud Volcanoes burst into eruption chiefly during the wet season. An examination of the recorded eruptions would seem to point to the reverse conclusion, as ten of the thirteen have taken place in the five dry months, and only three in the seven wet months. The author, however, does not consider that the observations made are sufficiently numerous to warrant a generalisation.

Mr. F. R. Mallet gives an account of the phosphatic nodules and rock of Mussorea. They are of a very suitable quality for the manufacture of manure, as the nodules contain 34·70 per cent of phosphoric anhydride and the rock to 30·16, equal respectively to 75·75 and 65·84 tricalcic phosphate.

Chemical Science and the Voice. An Address delivered by Dr. Carter Moffat at the Second Ammoniaphone Concert, June 12th, 1885, under the direction of Col. H. Mapleson.

The Ammoniaphone is a somewhat startling invention. By breathing through it a few times daily "the voice becomes much stronger and richer in quality, while a very large amount of good is done to the respiratory apparatus. By taking a few inhalations every day for a time the husky voice is made clear, and the weak delicate throat and lungs strong." Further, "to use the instrument now and again prevents to a great extent the user taking colds. The susceptibility to chills and throat and chest affections disappears." If certain "highly volatile antiseptics"—not named—are added to the vapours and gases ordinarily inhaled from the instrument, "we have a sure and certain remedy at hand for stopping hæmorrhage from the lungs."

Thus this instrument appeals to two distinct worlds, the musical and the medical. Whether it possesses the merits claimed for it practical experience alone can decide. We are told that the invention "is being used by numerous members of the Royal family, as well as by the Prime Minister and leading parliamentary men." We should be inclined to think that if this invention leads to an increase of speech-making, with which we are already overstocked, Dr. Carter Moffat will have but very slender claims upon public gratitude.

Turning now to the theory of the invention, we read that Dr. Moffat has found hydrogen peroxide and ammonia in the air and dew of Italy, and to these constituents of the atmosphere he ascribes the superior quality of the voice commonly met with, as it is supposed, among the natives of that country. But unless we are much mistaken hydrogen peroxide—hydroxyle as it is called by the gods—has been found in the air of every country where it has been carefully sought for. The same may be said of ammonia. The question then arises whether hydrogen peroxide and ammonia are found in larger proportions in the atmosphere of Italy than in that of other regions? We do not know of any analytical evidence to that effect, and Dr. C. Moffat does not supply any such in the lecture before us. One fact renders the abundant existence of hydrogen peroxide in Italy somewhat questionable, *viz.*, the prevalence there of malaria. Surely, if so efficient an antiseptic as hydrogen peroxide were exceptionally abundant in Italy, zymotic diseases ought there to be exceptionally rare.

A second question which we are unable to discuss is whether Italian voices really possess any well-marked superiority?

It may be, however, that Dr. Moffat's device may be practically useful, though founded upon a questionable theory.

Supplement to "Euclid and his Modern Rivals." Containing a Notice of Henrici's Geometry, together with Selections from the Reviews. London: Macmillan and Co.

THIS pamphlet is a criticism on modern text-books of geometry, presented in the form of a dialogue, or rather a trial at law. "Minos" has been retained by the ghost of Euclid to represent his interests, while Herr Niemand—a German professor—appears as counsel for Henrici and others.

The first incongruity is that the advocate on one side is represented as cross-examining the advocate on the other. Whether this method of presenting an argument is the best means, or even a good means, of arriving at truth is very questionable. He is a very poor man who cannot, if so disposed, put untenable arguments into the mouth of an imaginary opponent.

Mr. Dodgson then reviews the reviewers of his former treatise, with whom as a body he feels little satisfied. It is hinted by some of them that the esoteric object of the treatise is to uphold the interests of University examiners. Thus Mr. J. Magnus ("Educational Times") is quoted as saying, "But surely it must be admitted that methods of teaching a subject ought not to be considered from the standpoint of examinational requirements." Who will dare to say that in England not merely the methods of teaching, but the very subjects taught, are selected with reference to this point of view?

Text-Book of Structural and Physiological Botany. By OTTO W. THOMÉ, Rector of the High School, Cologne, and ALFRED W. BENNETT, B.Sc., F.L.S., Lecturer on Botany at St. Thomas's Hospital. Fifth Edition, revised and corrected. London: Longmans, Green, and Co.

WE have here a most useful Manual, somewhat the worse, however, for the very extensive references to examinations, and the mode of preparing for them, which are encountered both in the "Preface to the Fifth Edition" and in the "Editor's Preface." All such books, in reality, enforce the painful truth that a thorough knowledge of any subject and the ability to "pass" in it are not necessarily identical, the one being able to exist independently of the other. But without discussing the evidence on this subject, to which the British official mind is obstinately and wilfully blind, we must pass on to the work itself.

The authors, in the very outset, fully recognise the impossibility of fixing, in any definite manner, a boundary line between animals and plants, and the difficulty—to use the mildest term—of a natural classification: they then give a history of the science, omitting, however, all mention of Lindley, Bentham, St. Hilaire, Robert Brown,—who was styled by a German contemporary "botanicorum facile princeps,"—the two Hookers, Asa Gray, Boussingault, and Darwin! These omissions the editor supplies in a footnote, in which room might have been found for Ettingshausen, Heer, and Von Müller.

Passing over the successive chapters on the "Cell as an Individual," the "Cell as a Member of a Group of Similar Cells," the "Construction of the Plant out of Cells," and the "External Form of Plants," we come to a very full and ably written account of the "Life of the Plant." Here we find it stated that the nutrient substances of the plant—in other words, plant-food—are "carbon, oxygen, nitrogen, hydrogen, and sulphur," to which must be added "iron, calcium, potassium, magnesium, and phosphorus." The relative importance ascribed here to these elements scarcely agrees with that assigned to them by the farmer and the gardener.

Viola calaminaria is mentioned as an instance of a plant which always contains zinc, and which will grow on zinciferous soils only. To the widely diffused presence of copper, *e.g.*, in the cacao tree, there is no reference. The manner in which plants which live on decaying organic matter absorb their food, and are nourished, is pointed out as a problem still unsolved. As regards the alleged assimilation of free nitrogen, the authors, in common with the leading agricultural chemists of the day, take the negative view.

The fact that plants have a true respiration, in which oxygen is absorbed and carbonic acid given off, and that consequently in an atmosphere of pure carbonic acid they are suffocated, as are animals, is brought into notice. This is of the more importance since many well-educated persons still apply the term "respiration" to the process in which plants take up carbonic acid and give off free oxygen.

In speaking of nitrogen, the authors say "Whether non-parasitic plants absorb nitrogen also in the form of certain organic compounds is still undetermined." This error the editor corrects by reference to the carnivorous plants, such as *Drosera*, which absorb through their leaves nitrogenous substances "by a process of true digestion, precisely analogous to the digestion of animals, due to the presence of a ferment analogous with pepsine."

The function of insects in the fecundation of plants, and the habit of bees to visit in succession many flowers of the same kind, so that the pollen is not wasted, are admitted as fully established.

The effects of temperature, both upon germination and the maintenance of plant-life, are considered at some length. The editor adds in a footnote that some fungi, bacteria, and fungus-spores are able to withstand a temperature of nearly or quite that of boiling water. From the experiments of Dallinger and Drysdale it would appear that certain microphytes are not killed at temperatures below 300° F.

The authors do well to point out that the term "chemical rays" of light, as applied to the blue, violet, and ultra-violet radiations, is inaccurate and misleading, and should be abandoned. We do not see that, whilst expounding the effects of light upon vegetation, they mention that an excess of light, even when unconnected with heat, is distinctly injurious.

We are somewhat surprised to meet with the statement (p. 194) that in hybrids "the power of propagation is commonly defective, and they are often altogether infertile." Many observers, including the eminent botanist Prof. Meehan, maintain, on the contrary, that among vegetable hybrids fertility is the rule and sterility the exception.

The abnormal vital phenomena of plants, and their consequent abnormal developments, are very ably described. The same must be said of the peculiar diseases of plants, chiefly due to the attacks of vegetable and animal parasites.

As believers in the sugar-cane and its true sugar, we are not sorry to learn that a destructive fungus has attacked the beet. Eagerly as we long for the rout of the phylloxera, the potato-disease, and the blights affecting the coffee and the peach-trees, we hope no less devoutly that the beet disease may spread, and that "betose" may disappear from the earth.

In the section on "Special Morphology and Classification" we must note the very considerable space now devoted to the

Thallophytes since the importance of the part which they play in the economy of nature has come somewhat into notice.

The chapter on "Botanical Geography" naturally suggests the question how it is that the distribution of plants cannot, as it would seem, be brought into harmony with that of animals. If we take the system given by Mr. A. R. Wallace in his "Geographical Distribution of Animals" we find six grand regions, each subdivided into provinces, or divisions of an inferior rank, making altogether 24 provinces. The differences between the regions are plainly of a higher importance than the distinctions between the provinces of any one region.

In Griessbach's geographical classification here adopted we have no regions, but merely 24 provinces of equal rank. The boundaries, too, are far from coinciding. The neotropical region of Sclater and Wallace would include 7 provinces, not 4, as in animal geography. Griessbach makes a "region of Oceanic Islands," in which New Zealand, Madagascar, Feejee, the Azores, &c., figure along with the Falklands and Kerguelen's Land.

Here the authors do not attempt to show any common feature which should warrant countries so distinct in their flora being classed together. The Australian region of Griessbach does not coincide with that of Wallace. The former confines it to Australia proper and Tasmania, while with the latter it includes also New Zealand, the Eastern Islands beyond "Wallace's line," and the Pacific Islands.

These discrepancies are very unsatisfactory. If we consider to what an extent the fauna of any country depends upon its flora, and how greatly both fauna and flora are influenced by the same factors, we shall feel that there is here urgent need for further investigation.

From the point of view adopted by the authors, or rather we should say by Mr. Bennett, the work is excellent, and will render great service to that somewhat rare animal the true student, as well as to his mimic, the man who is preparing for an examination.

The Mount Morgan Gold Deposits. By R. L. JACK, Geologist to the Queensland Government.

THE discovery of gold in and near Mount Morgan, in Queensland, is of extraordinary interest, as the deposits are in an unusual formation. The author thinks that nothing but a thermal spring in the open air could have deposited the material in question. The gold and the accompanying iron may have been dissolved out of the "Mundic Reef," the gold possibly by chlorine produced by the contact of the pyrolusite present in the ironstone of Mount Morgan, with hydrochloric acid from the decomposition of chlorides. The siliceous sinter, containing in some cases as much as 10 ozs. 14 dwts. gold per ton, gives evidence of former geyser action. The hot spring is supposed to have originated subsequently to the formation of the desert sandstone.

The author thinks this discovery important, not merely from the large quantity of gold actually found, but as indicating that palæozoic reefs rich in gold extend under the cretaceous rocks in the western interior of Queensland.

The Museum. An Illustrated Monthly Journal for Collectors of all Classes and Young Naturalists. Vol. I., No. 2, June, 1885. Philadelphia: W. F. Fill and Co.

ONE portion—and one portion only—of this new journal has our hearty good wishes. As it ranks among its contributors men of such merit as Prof. Jos. Leedy, Dr. C. C. Abbott, and Mr. Herman Strecker, it can scarcely fail to give satisfaction to naturalists if they get a fair share of space.

We notice in the issue before us a biography of the illustrious American palæontologist, Prof. E. D. Cope. "Curious Facts about Snails," by E. A. Barber: the author mentions a shell of *Helix Cooperi* which had its coils turned to the left instead of to the right, as in the normal structure of the species. We are not quite content to dismiss this phenomenon as a "freak of Nature." "Philately," however, which is a newly coined word for the collecting of postage-stamps, is quite outside our scope.

Our Corner. Vol. V., No. 6, June 1, 1885.

"WORK for the Microscope," by Mr. J. Horner, is a sound, plainly written introduction to the use of this important instrument of research, and will doubtless guide not a few persons to its intelligent employment.

"The Heretic at Burlington House," by W. Greatheed,—a somewhile contributor to the "Mason College Magazine,"—seemed the possible title of irreverent criticisms on the learned societies established in that far western locality; but we find it a survey of the Exhibition at the Royal Academy, and as such falling in bulk outside our scope. But the last few lines we must quote with approval. Mr. Greatheed objects to "Mr. Armitage being allowed to fill up the dome of St. Paul's Cathedral with the common angelic monstrosities, devoid of the necessary complement of pectoral muscles. When will painters dissect out in a pigeon the organs of flight?" To the naturalist the sight of a human figure with a pair of wings fixed on about the shoulder-blades is a sight anything but pleasant.

"Science Corner" is brief, but interesting. Emmering, of Laningen, is quoted as saying that bees always show signs of irritation on the approach of a thunderstorm. According to M. Miklucho-Maclay the temperature of *Echidna hystrix* is only 28° C., and that of *Ornithorrhynchus paradoxus* 24·8° C., the mean body temperature of other mammals being 38·4° C. This the Editor justly regards as a piece of evidence in favour of the truth of Evolution.

The Ecclesiastical Gazette. Vol. XLVII., No 564, June 15, 1885.

We are unable to discover why this paper has been sent us, as it contains no intelligence on subjects which lie within our scope.

As a proof of the watchful and untiring malignity of the Bestiarians we quote the following passage:—At a meeting of the Church Missionary Society "A letter was read from Miss A. Marston, dated 95, Onslow Square, on the subject of vivisection in its possible bearings on medical missions. It was resolved—'That the question of vivisection not having come practically before the Committee, they do not feel themselves called upon to give any opinion on the subject of Miss Marston's letter; but they have the most perfect confidence in all their medical missionaries, and feel sure that they will never permit, either directly or indirectly, any proceeding of an inhuman character to be carried on.' The Secretaries were directed to send a copy of this Resolution to every medical missionary connected with the Society." Are we equally vigilant in defence of Science?

CORRESPONDENCE.

** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

PROCESSION OF CATERPILLARS.

THE other day, whilst walking over the plain here, I came upon a string of long hairy caterpillars, of a whitish, or rather pepper and salt, colour. They were following each other so closély that a little way off it looked like a big snake. No matter what was in the road, they kept strictly together. The procession was at the very least 12 feet long.

O. H. L. SLATER.

Port Augusta, South Australia.

THE WILD BIRDS PRESERVATION ACT.

To the Editor.

SIR,—Allow me to ask the question why it is that the above Act appears to be in some districts comparatively a dead letter? I happen to live in such a neighbourhood where this law is allowed to be broken with impunity, although we have a policeman to enforce it. What I refer chiefly to here is "birdnesting," which is not only destructive to the brood of our "meadow songsters," but is also most annoying to the farmer, who has the mortification of having his fences trampled down by perhaps a dozen boys. Should a farmer be seen crossing the road with his gun, the police will in this instance be down upon him. Now what I say is this: if we observe one part of a law and discard the rest, as in this case (for a farmer is not allowed to shoot birds), let us do away with such an Act altogether.—I remain yours, &c.,

SUB-ROSA.

May 25th, 1885.

[We copy this letter from the "Warrington Guardian" in proof that we are not singular in pronouncing the "Wild Birds' Preservation Act" a dead letter.—ED. J. S.]

NOTES.

Those who advocate the use of insects as food should remember that many insects contain cantharidine, formic acid, and other irritants not as yet studied.

According to "Science" the desecration of the Falls of Niagara has been stopped; the buildings and mills have been cleared away from the American shore and from Bath Island, and all points of view thrown freely open to the public. The cost to the State of New York has been 1,433,429 dollars.

"Light" speaks of the Witch of Endor as an "ancient medium."

A new chemical laboratory and museum are to be built in connection with Cambridge University at a cost of £70,000. But will the students be encouraged to undertake chemical research, and will such research, if successful, be a passport to honours?

Mr. W. H. Babcock ("Science") gives a case of a telephone wire having for a long time given forewarnings of storms, from six to twelve hours in advance.

Dr. J. Foster has recently read, before the Bradford Medico-Chirurgical Society, a very important paper on the physiological aspects of education. He remarked that the physiologist and the schoolmaster are at issue:—"The former will consider how he may best develope the brain and fit it for future usefulness; the latter, how he may get the most work out of it in the present." . . . "To enable the scholar to answer questions is not to educate him." The paper is an authoritative condemnation of the "results" system in education.

Why is it that, to men of culture, the females of the lower races of mankind are generally more repulsive than the males?

We must again urge our readers to do their utmost to prevent the return of any Bestiarian to Parliament at the approaching election.

The balance of the Darwin Memorial Fund, after paying for the statue and medallion, will be made over to the Royal Society to be invested, and the dividends or interest to be applied for the promotion of biological research.

Mr. C. Morris (Philadelphia Academy of Natural Sciences) regards the air-bladder of fishes as a degenerated organ, which formerly to some extent performed the function of a lung, enabling fishes to visit the land.

At the last meeting of the Biological Society of France M. Brown-Sequard gave some instances of allocheirism, an alteration of sensibility in which a touch or an injury on the right side of the body is felt at the corresponding point of the left side.

Claude Bernard, we are told, was a confirmed spiritualist.

The appearance of the swallows this year in France has been —Beaucaire and Pendensac (Gironde), March 23rd; Vendôme, March 31st; Poitiers, April 1st; Parc St. Maur, near Paris, April 4th; and Dunkirk, April 16th.

According to the "Brewer's Guardian" 25,000,000,000 gallons of carbonic acid are yearly emitted into the atmosphere of Britain from the fermentation of malt liquors.

We are sorry to find that the "Economical Section" of the British Association is not yet marked for amputation.

J. F. James ("Science") shows from the first appearance of early flowers that in the Ohio Valley—just as in England—the spring of 1885 has been abnormally late.

We have omitted to put on record the death of C. T. E. von Siebold, founder of the "Zeitschrift für Wissenschaftliche Zoologie."

A statue of Linnæus was formally inaugurated at Stockholm on May 13th.

According to Hindu legends the successive incarnations of Vishnu ascended from lower to higher forms; first a fish, then a tortoise, a boar, a lion, a dwarf (ape), &c.

A. Gruber ("Biolog. Central-Blatt") has succeeded in dividing and re-dividing Infusoria (*Stentor cæruleus*) until sixteen individuals, each perfect, were produced from the original subject. Segments without a nucleus healed after the operation, but never became perfect animals.

German sanitary authorities are vainly seeking to combat Trichinæ and their evil effects by a more rigid inspection of all swine slaughtered for food. The remedy lies with the public; let them desist from the use of raw ham, "hackfleisch" (chopped raw pork), and "speck-salat," and the mischief will be at an end.

Count de la Croix de Vaubois, who has eaten preserved locusts at Ouargla, thinks that they might have been good if the oil had not been rancid and mixed with sand.

According to the Bulletin de l'Académie Royale de Belgique" the poison of the scorpion is opalescent, possesses a faintly alkaline reaction, contains in suspension a great number of fine rounded granules, and seems analogous to the echidnine of the poison of vipers. It seems to be a poison like curare, acting on the nerves of motion, but not on those of sensation.

"Cosmos" raises the question how it comes that so few dead elephants, and indeed wild animals generally, are ever found?

The same journal refers to a great number of cases of madness, said to have occurred some years ago, after spiritualistic experiments.

Anti-vaccinationists will, we fear, be little edified with the conclusions of the German Commission on the Vaccination question which have been recently submitted to the Reichstag:—

1. One attack of smallpox, with rare exceptions, confers immunity from the disease.
2. Vaccination affords similar protection.
3. The duration of this protection varies within wide limits, but amounts on the average to ten years.
4. To obtain sufficient protection two developed marks are needful.
5. Re-vaccination should take place after the lapse of ten years.
6. The vaccination of the surrounding population increases the relative protection of the individual, and vaccination has therefore not merely a personal but a general value.
7. In vaccination with human lymph the danger of the transfer of syphilis, though small, is not absolutely excluded.
8. Since the introduction of vaccination there has been no demonstrable increase of diseases which can be regarded as a consequence of vaccination.

Mr. Edward M. Nelson remarks ("English Mechanic," No. 1052, p. 247, May 22, 1885) that "while the literature of the celestial telescope is extensive, and correspondence frequent, that somehow or other the terrestrial telescope has been left out in the cold." The paper describes the properties of the telescope proper, and how it differs from the Galilean binocular field-glass now so much in use. For every purpose, except use at the theatre and on board a steamer,—where the vibration renders the use of the long telescope difficult,—Mr. Nelson considers the latter in every way superior, and remarks "that a pair of binoculars is often given as a present or a prize, quite regardless of the fact that a pair of binoculars is like a pair of boots—to be of use they must fit. So important is it that the centres of binoculars should exactly correspond with the centres of the eyes of the persons using them that the slight divergence of even 1-16th of an inch is quite sufficient to detract from the pleasure of using them. Further, it is stated that the nearest approach to optical perfection must be sought for in a lens whose focus = 15 times its aperture. What shall we say, then, of the binocular field-glass the focus of whose objectives does not exceed 3 times their apertures." "It is a sad fact that at the present day the terrestrial telescope, apart from the navy, is only to be found in the hands of scorers for rifle-shooting, and of a few infatuated individuals who still persist in carrying about these antiquated instruments." Mr. Nelson gives a good account of the most useful kinds of telescopes made; also their respective uses, and what kind of performance may reasonably be expected from them. Very full directions are given for the testing of terrestrial telescopes, and the reader is put on his guard against two very common defects,—error in the size and position of the diaphragm in the erector, and the cutting off of the aperture of the object-glass by the insertion of stops. Only those who have made use of a good small telescope know what can be done with it. It is one of the field naturalist's most valuable tools: an animal can be watched, the face of a cliff examined, plants detected, geological details noted, and, if the focussing slide is long enough, an observation can be taken at as short a distance as 20 feet; the view given is surprising, the details of flowers and insects are rendered in a manner almost microscopical, and the picture rendered brilliant by its isolation from all surroundings; and the instrument doing all this will give a splendid view of the moon, and show Jupiter's satellites and Saturn's ring.

J. Schlesinger ("*Zeitschrift des Œster. Ingenieur-Vereins*") maintains that the doctrine of the inertia of mass is an error, and attempts to explain all mechanical and other physical phenomena by assuming that space is an absolutely persistent and fixed substance penetrable by all the real things of the world, and that energy is also a substance penetrable by all the real things and moving in a capillary manner in the fixed substance of space. [The term "real" is here taken in its philosophical sense.]

The total number of licenses for physiological experimentation during 1884 was 49, and the number of experiments performed was 145. Of these 99 consisted simply in the introduction of a virus; 24 were experiments in cases of suspected poisoning; 10 were experiments on the action of certain Fungi upon fish, and 5 on the effects of absolutely pure water upon fish. [So much for the "cutting up alive."]

The French Association for the Advancement of Science will meet at Grenoble, August 13th, 1885, under the presidency of Prof. Verneuil.

M. Richard ("Comptes Rendus") has examined the effect of cocaine upon the pulmonic gasteropods, earthworms, crustaceans, hydræ, &c.

According to Dr. Gordon the circulation of the blood was familiar to the Chinese physicians 2000 years ago.

M. Magnan cites a number of cases of madness among Bestiarians. One woman first renounced animal food, then took in all stray dogs, and finally went round to the butchers begging them not to slaughter any more cattle. She became formally mad, and was received as a patient at Charenton.

Prof. Dewar and Dr. Tidy, after having undertaken for their own satisfaction a prolonged inquiry into the working of the "A B C" Sewage Process as carried on at Aylesbury, have issued a Report, of which the following are the principal points :—

1. That the A B C Process produces a clear effluent free from suspended matter and devoid of smell.
2. That the effluent is uniform notwithstanding the very varied nature and concentration of the sewage.
3. That as the strength of the sewage increases the precipitation is more complete.
4. That the Process removes over 80 per cent of the total oxidisable organic matter.
5. That it precipitates 60 per cent of the organic matter in solution, and of the residue left in the effluent at least two-thirds are non-albuminous, and therefore of a nature less liable to putrefactive and other changes.
6. That the Process is carried on without nuisance, the sewage being immediately and completely deodorised, and the entire Works free from any objectionable smell.
7. That it produces a manure containing an average of 3·8 per cent of ammonia calculated on the perfectly dry manure, and also 5 per cent of phosphates reckoned as tricalcic phosphate.

A disgraceful instance has recently occurred of a poor woman being compelled, by School Board persecution, to send one of her children to school while some others of her family were suffering from measles ! Such things are the inevitable outcome of the "payment by results."

The "Philadelphia Call" quoted in the "American Naturalist," gives an interesting case of a dog feeling ashamed of a dishonest act. It "saw a cutlet near the edge of the board, and yielded to the temptation to steal the meat. The cutlet was slily seized and taken under the sofa, the dog's owner pretending not to see the theft. But the conscience of the little terrier got the better of its hunger : it brought the cutlet back, laid it at the feet of its master, hung its head in shame, and slunk away."

Prof. H. N. Mosely, F.R.S., contends that all the main groups of the animal kingdom first came into existence along the shores of the sea,—in the so-called littoral zone,—and that here also the first attached and branching plants were developed. But both the animals and plants of the shores were probably derived from pelagic ancestors.

Prof. A. W. Rücker, F.R.S., from an investigation of liquid films, arrives at the conclusion that the diameter of a molecule is considerably less than 2×10^{-6} millimetres.

We must hope that the Platypus will not be extirpated before its life-history has been completely worked out. Mr. Caldwell is searching for them, and has obtained in six weeks 500 specimens.

Dr. Aurivillius finds that the uniformity of the Arctic fauna becomes more striking as we approach the Pole, but that three subdivisions are manifest,—the Scandinavian, the Asiatic, and the American.

M. Felix Lucas, in a recent study on the radiations of incandescent carbons, shows that the electric arc-light *decreases* in luminosity if the electric intensity or the temperature are carried beyond a certain limit. The radiations become first red, then white, and finally pass into the ultra-violet, where they no longer act upon the human sight.

V. Horsley, F.R.C.S., in a lecture delivered at the Royal Institution on the "Motor-Centres of the Brain and the Mechanism of the Will," showed that as a rule both cerebral hemispheres are engaged at once in receiving and considering one idea; that under no circumstances can two ideas either be considered or acted upon attentively at the same moment; that the brain is a single instrument, and that our idea of our being single individuals is due entirely to this single action of the brain.

Mr. J. S. Kingsley has revised the inter-relationships of the arthropods. He finds that the arachnids are more closely allied to the crustaceans than to the hexapods and myriapods, with which they are usually classed. The arachnids and the hexapods have little in common, and the diviston Tracheata is artificial and not natural.

"Light" says "The limitation at present placed on natural laws must be relaxed."

Holland, it seems, is blessed with a Society for the Prevention of Cruelty to Animals, which body has petitioned the Government to introduce the restrictions on physiological experiments drawn up by the Prussian authorities,—restrictions not so bad as those in force in this country, but which certainly concede too much.

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THE

JOURNAL OF SCIENCE.

AUGUST, 1885.

I. A CHARACTERISATION OF MR. DARWIN'S MASTERPIECE.[*]

By OSWALD DAWSON.

> A marble statue of Charles Darwin was unveiled yesterday morning at the Natural History Museum in Cromwell Road, South Kensington, and was received in trust for the nation by the Prince of Wales, as representing the trustees of the British Museum. The statue is placed on the landing of the principal staircase leading from the great hall. . . . The committee also proposed that a medallion should be placed in Westminster Abbey.—*Morning Post.*

> We are all agreed to regard [natural selection] as at least an important factor in the origin of species.—ST. GEORGE MIVART.

> I call upon the doughtiest here to bear
> This witness unto Truth,—that though he go
> Goliath-armed against her, he shall lie
> Felled by a stripling shepherd in a smock
> Who fights for her.—*Diabolus Amans.*

THE speech of Professor Huxley when unveiling the Darwin statue, on June 9th, contained a recognition of the fact that, although "the phase of vehement "opposition" had passed, yet honourable antagonists (and

---

[*] It may be well to give one or two facts showing that the *Origin of Species* is regarded as Mr. Darwin's masterpiece. This work, which has just reached its twenty-eighth thousand, is the only one mentioned in Professor Huxley's *Nature* Memorial Notice, or in his speech at the unveiling of the Darwin statue.

The following relevant quotation from the 'Half-Holiday Handbook' *Round Bromley and Keston* will interest intending pilgrims:—"Though his by implication dishonourable ones) were still to be numbered. The clause running "Whatever may be the verdict "of posterity upon this or that opinion which Mr. Darwin "has propounded" indicates that, whatever the boast of Evolution, Mr. Darwin's opinions are not for all time victorious all along the line. All these announcements are admirably true. Assuredly *vehement* opposition has subsided since lithesome theology saw its way to countenance Darwinism without renouncing orthodoxy. Assuredly Mr. Darwin's assailants are no defunct race; and as assuredly there are anti-Darwinians and anti-Darwinians. And most assuredly, too, is Darwinism still *sub judice.*

The following article aims to be a portrait of the literary, scientific, philosophical, and moral characteristics of Mr. Darwin's masterpiece; and as the features in a photograph are unaffected by the integrity of the operator at the camera, so my task is, as it were, passive. I wish to obtrude no personal observations other than that the previous sentence must not be construed into a concession that prejudice has influenced the composition of this article; inasmuch as the only emotion which has exercised me in this connection has been one of some satisfaction on finding that the literary, scientific, and philosophical merits of Mr. Darwin's masterpiece are not of such a magnitude as to neutralise the moral obliquity displayed therein. The resemblance to a photograph is, however, incomplete, for the many laudable features of Mr. Darwin's works and character are not detailed here, while at the same time the article does not profess to be an exhaustive catalogue of the defects. No space will be devoted to repetition of these prefatory remarks (nor to any concluding ones). Regard for them is therefore now, for fairness' sake, solicited.

Literary Characteristics.

The term literary is here used in a wide sense; my task not being to collect the passages of "unstudied eloquence

---

"body lies in Westminster Abbey, his best monument will be that 'Origin of "Species' which, it has been declared, marks a new epoch in the history of "scientific thought. His late residence is called Downe House, and is situated "on the south of the village in Luxted Lane. The road on the north side of "the church leads to High Elms, the country seat of Sir John Lubbock, "Bart., M.P.," &c.

The term here, however, must on many occasions when used be understood to include also the *Variation under Domestication*, and the volumes which were to follow. Of course under *Variation under Nature* is included variation under nature, the struggle for existence, and natural selection.

"which here and there breaks out in the *Origin of Species*," in alleged contrast to the flatness of Mr. Herbert Spencer's writings, but rather to enquire—Is the work a finished edifice and a coherent whole? Do we frequently encounter dogmatism, *petitio principii*, &c.? Are courtesy to opponents and loyal recognition of predecessors everywhere conspicuous?

The *Origin of Species* is not a finished edifice. It is an "abstract." Nine years after its publication the first instalment of the work proper appeared, and the succeeding fourteen years of Mr. Darwin's life did not witness the transition of either of the two remaining instalments from a manuscript to a published existence. The work was, notwithstanding, "nearly finished" in 1859 (p. 1).* "The "cause [thereof] is well-known to have been the continued "pressure of ill-health," writes one. "Perhaps the greater "interest of new experimental work" supplemented the cause of ill-health, says another; while a third relates that "so successful was the work that Mr. Darwin did not find it "necessary to publish all the volumes of accumulated facts "which he had intended to supply by way of evidence." But inasmuch as two editions of the *Descent of Man*, "the publication of which" Mr. Wallace tells us "was not "anticipated by its author three years before," betoken no intellectual collapse; and inasmuch as the *Descent of Man* is not experimental work, one prefers to reject the former solution; especially when we learn that Mr. Darwin told Prof. John Fiske that "it seemed no longer so necessary as "it had once seemed" to publish the remaining volumes.

Now while "no one," says Mr. Darwin, "can feel more "sensible than I do of the necessity of hereafter publishing "detail all the facts, with references, on which my conclu-"sions have been grounded" (p. 2), some may suspect that the interests of many of those conclusions were not prejudicially affected by the abandonment of the enterprise; for concerning the *Variation under Domestication* reasons will be given in the following section for endorsing the opinion of Dr. Mivart that it is "somewhat problematical how far" this work is calculated to favour Mr. Darwin's doctrines, while concerning the *Variation under Nature* considerations will be mentioned rendering it probable that, in some respects, "Mr. Darwin gains rather than loses by the necessity which he so often deplores, of having to curtail his "evidence," to adopt the phraseology appled by the *London Reviewer* of the *Or. of Sp.* to this last-named work; while concerning the evidence corroborative of Evolution (the subject-matter of the final instalment, or chiefly so) a cynic might say that so successful was the *Or. of Sp.* in assimilating the doctrine of "descent with modification" with that of "descent with modification through variation "and natural selection," that Mr. Darwin did not think it necessary to publish further evidence of their identity in his own mind,—a remark well adapted to serve as a transition to the discussion of the second heading.

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* The title, *Origin of Species*, will be omitted throughout. The edition quoted from is the sixth, with additions and corrections to 1872, in every instance when not otherwise specified. Pages preceded by the numerals i. or ii. refer to the first or second volume of the *Variation of Animals and Plants under Domestication*, second edition, revised, 1875.

The *Or. of Sp.* is "one long argument" (p. 404), with "two distinct objects in view; firstly, to show that species "had not been separately created, and secondly, that natural selection had been the chief agent of change" (*Descent of Man*, p. 61).

The consequence of this procedure has been now a confusion, now an identification of the theory of Evolution and the theory of Natural Selection throughout the *Or. of Sp.;* with the result of floating the proposition that the issue is 'creation *versus* natural selection,' rather than 'creation *versus* evolution.' Mr. Samuel Butler remarks:— "To do this prevents the reader from bearing in mind that "the 'evolution by means of the circumstance-suiting "'power of plants and animals,' as advanced by the earlier "evolutionists, and 'evolution by means of lucky accidents,' "[may] the one be true and the other untrue. . . . Hence "[also] when he falls in with such writers as Professor "Mivart and the Rev. J. J. Murphy . . . he imagines that "evolution has much less to say for itself than it really has." To give details. In explaining similarity of pattern among diverse orders, choice is offered between creation and "the theory of the selection of successive slight modifications" (p. 383), and again in accounting for serial homologies (p. 384), in connection with palæontology (pp. 290, 313, 407), in connection with distribution (p. 362); while on the other hand "the two theories of independent creation and "descent with modification" are mentioned in connection with the last-named topic on p. 347; while there is a like absence of qualification in the treatment of classification on pp. 365 and 369, and of rudimentary organs on pp. 400 and 402, and both combined on p. 373. The same end was at other times gained by a substitution of one theory for the other in the course of a single argument. Thus the title of

Chapter VI. is "Difficulties of the Theory," no attempt to advance the general doctrine of descent with modification having been made in the previous chapters, which treat of selection, &c. The contents, however, commence with "Difficulties of the Theory of Descent with Modification." —but before the reader turns the page he is asked "Can we "believe that *natural selection** could produce" a giraffe's tail and an eye? "Can instincts be acquired and modified "through natural selection?" Mr. Samuel Butler, citing analogous instances from pp. 406, 416, and 419, remarks:— "This is calculated to mislead." Or, again, where descent was once the term, natural selection is substituted in a later edition (ed. 1, p. 188; ed. 6, p. 145). In corresponding fashion the appellations "my," "our," and "the" theory are indiscriminately employed. "My view" pitted against "the ordinary view of creation" on p. 351, in connection with distribution, may refer to descent with modification simply, while in the summary on *natural selection* it is stated that "on my theory unity of type is explained by unity of "*descent*" (p. 166). It is similarly used in connection with hybridism on p. 236; and in like manner "our theory" is spoken of in connection with distribution at p. 359, here referring to evolution, whereas the same expression on p. 375 presumably refers to natural selection, and yet again to evolution on p. 379. Lastly, the "view here maintained," on pp. 354 and 389, refers to evolution, distribution and morphology being here under discussion, though the phrase "through variation and natural selection" is appended on pp. 290 and 313, palæontology being here the subject-matter of debate. Now (limiting our questioning to the last sentence), are we to infer that Mr. Darwin found support for natural selection in palæontology rather than in distribution and morphology?

Mr. Darwin feared that "it will indeed be thought that "[he had] an overweening confidence" in his theory, and he it was who remarked "Great is the power of steady mis-"representation" (pp. 231, 421). Well, overweening or no, his confidence was such as to permit a very steady representation of the view that "through variation and natural "selection" was an indispensable appendage to the phrase "descent with modification," and this notwithstanding a recognition of a modern school of saltatory evolutionists, and the circumstance that the Historical Sketch mentions yet other agencies than saltation and selection as advocated by a "justly-celebrated naturalist" and by "our great philosopher (pp. xiii., xix., and *Descent of Man*, p. 123). And when confidence takes this shape it becomes the parent of dogmatism. And a work thus characterised in its *ensemble* will rouse suspicion concerning its *modus operandi* in particular instances. And we *do* find in the *Or. of Sp.* those literary misdemeanours which Dr. Mivart insists are so conspicuous in the *Descent of Man*, namely, dogmatism and *petitio principii*.

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* The italics are mine throughout unless otherwise stated.

The reader should ever be on the alert to distinguish between Mr. Darwin's statements in natural history and his expression of opinion. To cite an interesting fact:—For some reason Mr. Darwin substituted the statement that "*there is no difficulty in supposing*" that missing links "formerly existed," "and that each was developed [owing "to its] having been useful to its possessor" (p. 139, also ed. 5), for "*I see no difficulty in supposing*" that missing links "formerly existed," "and that each grade of structure was "useful to its possessor" (ed. 4, p. 208). Mr. Darwin affirms that "as modern geology has almost banished such "views as the excavation of a great valley by a single diluvial wave, so will natural selection banish the belief of the "continued creation of new organised beings, or of any "great and sudden modification in their structure" (pp. 75, 76); the proviso "if it be a true principle," inserted before the word "banish" in the first edition, being here withdrawn.

In arguing against creation (p. 365) Mr. Darwin styles "the *vera causa* of community of descent" (p. 125) "the "only known cause of close similarity in organic beings." Possibly he is here referring to the close similarity of the sexes, for he does "look at all the species of the same genus "as having as certainly descended from a common progenitor as have the two sexes of any one species" (p. 124), in the course of the argument implying that the special creation school holds such hypothesis concerning the differentiation of the sexes. Circumstances will permit me here to simply remind the reader that a not insignificant section of that school teach that "male and female created he them" (Adam and Eve), and that not only were they bidden to "be fruitful and multiply," but that great whales and winged fowl were saluted with the same mandate. Doubtless Moses thought it as little incumbent upon him to catalogue the secondary sexual characters of *Homo*, or other animals, as to enumerate the names applied by Adam to the several creatures brought unto him on that unique occasion.

The statement that "the whole economy of Nature, with "every fact on distribution . . . and variation, will be dimly "seen or quite misunderstood" unless "the truth of the "universal struggle for life . . . be thoroughly engrained in the mind" (p. 49) sounds like a presupposing of the truth of some such solution as the very one on the point of being contended for.

A volume so indefinite as to general aim invites enquiry concerning the amount of harmony manifest in the marshalling of the arguments. And the answer is that many of Mr. Darwin's propositions are so vitiated by incoherence as to render his real teaching inaccessible. To give some instances:—According to Mr. Darwin himself, "in former "editions" he *spoke* as if the preservation of "any single "strongly-marked variation" "had frequently occurred," though he *saw* that such would be "a rare event" (p. 71). We learn that "in a state of Nature . . . animals and "plants . . . have to struggle for existence from the hour "of their birth to that of their death" (ii., 219), yet "when we reflect on the struggle we may console ourselves "with the full belief that the war of Nature is not incessant" (p. 61). Again, not only is the insensibly slow rate of organic change repeatedly insisted upon, but modification under Nature is contrasted constantly with modification under domestication, the latter, though very slow, being the faster of the two; while, further, we learn that 140 millions of years can hardly be considered sufficient for pre-Cambrian evolution, and that 60 million years appears a very short time for that occurring in post-Cambrian times (p. 206); also that, "with respect to the lapse of time not having "been sufficient for the assumed amount of organic change, ". . . this objection, as urged by Sir William Thomson, is "probably one of the gravest as yet advanced" (p. 409); and all this notwithstanding that "we are also *quite ignorant* "at how rapid a rate organisms, whether high or low in the "scale, may be modified under favourable conditions" (*Descent of Man*, p. 156).

Courtesy to opponents and loyal recognition of predecessors are the remaining topics promised discussion under the present head. One instance of each shall occupy us.

Mr. Darwin introduces Dr. Mivart to his readers as "a distinguished zoologist" who "has recently collected "all the objections . . . against the theory," and "illus"trated them with admirable art and force" (p. 176), thereby convincing Mr. Darwin of, *inter alia*, "much partial "error" (p. 177). He recapitulates the illustrations discussed, and mentions Dr. Mivart's saltatory hypothesis, adding "some naturalists agree with him" (p. 201). He also admits that, by the discussion, "a good opportunity "has been afforded for enlarging" on a subject not heretofore "treated at sufficient length" (p. 198). Whether, then, his remark that he had "considered *enough, perhaps more* "*than enough*, of the cases, selected with care by a skilful "naturalist" (p. 198), was a conclusion characterised by courtesy the reader will please judge.

Mr. Darwin frequently couples Mr. Wallace's name with his own, and styles the latter's 'contribution' of 1858 "an excellent memoir" (p. 1), in which "the theory of "natural selection is promulgated with admirable force and "clearness" (p. xxi.). But what of the earlier 'contribution' of 1855? Is it not strange that this is ignored in an historical sketch where room was found to announce that Rafinesque thought "that all species *might have been* varieties "once," "*except* the original types"; that d'Halloy deemed creation *less probable* than evolution; or even that Professor Huxley considered evolution "unproven"—not to mention Dr. Freke? Did Mr. Darwin know of this Sarawak essay? Yes; for in the first edition of the *Or. of Sp.* he quoted therefrom Mr. Wallace's law that "Every species has come "into existence, coincident both in space and time, with a "pre-existing closely allied species," adding—"And I now "know, from correspondence, that this coincidence he attributes to generation with modification" (p. 355), just as though the Ternate essay had never been written!

The above law was conceived by Mr. Wallace as early as 1845, and since then he had taken "every opportunity of "testing it by all the newly-ascertained facts with which he "had become acquainted or had been able to observe himself," for he deemed the advent to new species to be "the most "difficult and at the same time the most interesting problem "in the natural history of the Earth." He attributed the characters of the plants and animals of the Galapagos to their having been "first peopled, like other newly-formed "islands, by the action of winds and currents, at a period sufficiently remote to have had the original species die out, and the modified prototypes only remain." He considered that "the risings and fallings in the scale of organisation "[can alone] be in every case explained" by supposing that "lower forms which have better resisted the modified physical conditions have served as the antitypes on which to "found the new races." He speaks of "modifications of "structure and organisation" being "given" to groups.

In his Preface this most modest writer refers to the Ternate *and Sarawak* contributions as having won him honour as an independent originator.

The immediate causes of the publication of the *Or. of Sp.* in 1859 are well known.

Scientific Characteristics.

Of more moment than any question hitherto treated is the ensuing enquiry:—Does Mr. Darwin's masterpiece favour Darwinism? It may be asked how, if that work really shows the literary blemishes depicted above, can one hope to ascertain the meaning of Darwinism? The question is a formidable one, but I must mention that in the December (1884) issue of this Journal I ventured to offer "a "definition of Darwinism, sufficiently succinct for mnemo-"nical purposes, and amply substantiated by copious "quotations." For the benefit of such as did not avail themselves of the hint to commit it to memory, and also for the use of those who were not subscribers prior to 1885, I must copy it here:—

> From one to at most ten pre-Cambrian, presumably unicellular organisms, created, and vivified by the Creator's breath, have arisen, without any subsequent interference, and we can hardly believe otherwise than without beneficent guidance, the structures and the bodily and mental activities of all organisms, by the accumulation, mainly by Natural Selection, of variations so minute as to be appreciable only to well-trained eyes, occurring in correlation but not in co-ordination with related variations, affecting single individuals, inducing intermittent modification, and being determined in their nature by an innate idiosyncratic plasticity, the chief ultimate cause of which is probably the accumulating action of changing conditions upon the parents, but more especially remoter ancestors, of the varying individual.

It has been alleged by several writers that Mr. Darwin repudiated Darwinism, or even natural selection. Though very erroneous this statement has a substratum of foundation, as I shall show at some length.

Idiosyncratic plasticity is the starting-point of Darwinism.

> Mr. Darwin perceived the liability of the obliteration of these variations [resulting from idiosyncratic plasticity]. In former editions he "spoke" as if the preservation "of any single strongly-marked variation" "had fre-"quently occurred," though he "saw" that such preservation would be "a "rare event" (p. 71). Nevertheless, until reading an able and valuable article "in the 'North British Review' (1867), [he] did not appreciate *how rarely* "single variations *whether slight or* strongly marked, could be perpetuated" (*Ibid.*). . . .
>
> "To the effects of intercrossing in eliminating variations of all kinds I "shall have to recur [the subject having already been once postponed (p. 34);]

"but it may be here remarked that most animals and plants keep to their "proper homes, and do not needlessly *wander about*; we see this even with "migratory *birds*, which almost always return to the same spot" (p. 72). He subsequently recurs as promised—to remark that "Intercrossing will "chiefly affect those animals which unite for each birth and *wander much*; "for instance, *birds*" (p. 80). . . .

Having admitted that free intercrossing will "check, by blending together, "any slight deviation" (p. 11), in summing up he finds that "the result will "often be greatly retarded by free intercrossing" (p. 84). In the *Var. under Dom.* he considers the effects "so obvious that they need not be discussed at "much length" (ii., 62) for "with respect to the very slight differences by "which individuals of the same sub-variety, or even of allied varieties, are "characterised, it is obvious that free intercrossing would soon obliterate such "small distinctions" (ii., 67) . . .

It better ensures the propagation of a new character if both parents are similarly characterised (i., 460). "In the great majority of cases a new cha- "racter . . . is not strongly inherited"; judicious watching is necessary (ii., 177). "In a *few rare* cases peculiarities fail to be inherited, apparently "from the force of inheritance being too strong" (i., 465; ii., 58), but "when "any deviation in structure or constitution is common to both parents, this is "often transmitted in an augmented degree to the offspring" (p. 237).

Let it be "remembered that selection may be applied to the family" (p. 230).

The topic last mentioned occupies thirty lines of the *Or. of Sp.*, and is applied solely to the elucidation of the inheritance of instincts by neuter insects. It is pronounced an "explanation" in contradistinction to an "exposition":—

The root of the question really consists in whether or not it is possible to suppose that natural selection may operate on specific types as distinguished from individual members of species. During his lifetime I had the advantage of discussing this question with Mr. Darwin, and I ascertained from him that it had greatly occupied his thoughts while writing the *Origin of Species*, but that finding it to be a question of so much intricacy he deemed it unadvisable to enter upon its exposition—*Mental Evolution in Animals*, by GEORGE JOHN ROMANES, M.A , LL.D., F.R.S. London, 1883 (p. 298).

The Inheritance of Instincts by Neuter Insects.—This difficulty is fully discussed by Mr. Darwin in the *Origin of Species*, but his explanation of it is, as usual, ignored by Mr. Mivart. [The passage on p. 230 is then cited.]—"Professor Mivart on Instinct," by GEORGE J. ROMANES, in the *Fortnightly Review* for July, 1885.

Recent politics (*re* the *arrangement*, not *agreement*, with Russia) are here recalled. It is all very well to talk about the "preservation of favoured RACES in the struggle for "life," as it may be sensible to bid housewives "Take care "of the pence, and the *pounds* will take care of themselves;" but when there is no prospect of either the races or the pounds ever arriving, it is a tantalising sub-title or motto to the biologist or housewife, as the case may be.

The evidence for Darwinism to be found in the *Or. of Sp.* fluctuates about zero. Of convergence of probabilities, recently insisted upon by Dr. W. B. Carpenter, there is barely a semblance.

It is no reproach to the *Var. under Dom.* that it does not demonstrate Mr. Darwin's doctrines; no more than if a structure consisting of spokes without fellies fails to act as a wheel. The question is, rather, Does it favour them? The answer is, By no means, unreservedly. First, as to inheritance. Many facts related to show its force very doubtfully favour the view that idiosyncratic plasticity gives promise of exerting sufficient power for Darwinian purposes. Numerous instances "showing how feeble, capricious, or "deficient the power of inheritance sometimes is" are given, and "numerous analogous facts could be given" (i., 461). "Many analogous facts could be given" (i. 464), &c., though many such are explicable (i., 470-72).

It must be mentioned that Mr. Darwin concludes his summary (ii., 61) by expressing full confidence in the success of the enterprise, thus:—"In these laws of Inherit- "ance we see an ample provision for the production, "through variability and natural selection, of new specific "forms."

Next, as to variation. The copious nature of unutilised data is again conspicuous, here in the treatment of factors ancillary to the prime Darwinian one, namely, the indirect and indefinite action of changing conditions. We not only get evidence "showing that *extremely slight* differences, "within the same country, or during different seasons, "certainly produce an appreciable effect, at least on varie- "ties in an unstable condition" (ii., 262); are told that "all horticulturists are unanimous that certain varieties are "affected by very slight differences in the nature of the "artificial compost in which they are grown, and by the "natural soil of the district, as well as by the season" (*ibid.*), but learn that "many similar facts could be given" (p. 264), and that "the present chapters were written before I had "read Mr. Herbert Spencer's work, so that I have not been "able to make so much use of it as I should otherwise pro- "bably have done" (ii., 270).

Further, Mr. Darwin is proud of his treatment of use and disuse (p. 176), occupying eight pages, a third thereof being printed in small type, while the section on changed and inherited habits of life announces that "endless similar "facts could be given in the animal and vegetable king- "doms" (ii., 29). The summary notices that "corporeal, "periodical, and mental habits, *though the latter have been* "*almost passed over in this work*, become changed under "domestication, and the changes are often inherited. Such "changed habits in an organic being, especially when living "a free life, would often lead to the augmented or diminished use of various organs, and consequently to their "modification" (ii., 346).

Lastly, elsewhere, Mr. Darwin allows that he formerly underrated the results of spontanous variation independent of natural selection (*Descent of Man*, p. 61). Some deem this a concession of great consequence. For their misjudgment, if such it be, excuses might be made. Were that not so, I fail to see anything unjust and unbecoming (to use Prof. Huxley's own words) in enumerating those points upon which Mr. Darwin has modified his opinions.

We now pass to the *Variation under Nature*. "To treat "this subject properly," writes Mr. Darwin, "a long catalogue of dry facts ought to be given; but these I shall "reserve for a future work" (p. 33). As is well known, the world is more familiar with these favourite expressions about factual catalogues and future works than with the things themselves. In the *Var. under Dom.*, upon several occasions, Mr. Darwin arrested himself when approaching the topic of variation under Nature, remarking that it would be travelling beyond his proper limit to discuss it there, or to like effect. In short, every means calculated to kindle curiosity is added to the intrinsic interest of an instalment which a logician might possibly have made the "*caput magnum*" of his *opus magnum.*

It behoves me to specify the reasons for believing that the *Variation under Nature*, had it ever emerged from manuscript, would have justified some measure of unfavourable characterisation.

In the first place, the procedure of the *Or. of Sp.* being to show how evolution might be effected, and *afterwards* to show that it had occurred, it is possible that, in the expansion of Chapter II., the word-war about the meaning of species might have suffered amplification. Now the question of the nature of species belongs either to that department of physiology which discusses hybridism (for I presume this is still the criterion), or to that of philosophy which discerns the Creator's motives, or to both; and discussions thereon which consist of tabulations of the arbitrary "opinions of "naturalists having sound judgment and wide experience" (p. 37), but who lack the requisite physiological data or spiritual pretensions, are of a value not at once very obvious as bearing upon Evolution. They may, of course, have other uses.

The second main point discussed in Chapter II. is likewise partially beyond the sphere of natural science. On looking to a suitable quarter we find the following answer is made :—

> There is no reason why there should not be features of similarity between varieties and species. . . . As it pleased Him to stamp the features of one great family on all organic beings by the evident connection that subsists between diverse species and genera, . . . [so] it was to be expected that varieties also would come under the same law of harmony, the same bond of origin and design. . . . Analogies between varieties and species might be, as we say, part of the Creator's harmonious plan, or, as Mr. Darwin says, part of a law of identity between varieties and species: they *might** be either; therefore, to quote them as proof of one side of the question is against every rule of fair evidence.

But I must confess to much hesitation in reckoning this a vulnerable point. However, the quotation may serve to show that there *is* an *altera pars*.

Thirdly, the *Variation under Nature* would probably have been dogmatic. The statement commencing the summary of the chapter on Natural Selection is the *Origin of Species*, and running thus :—" If under changing conditions of life " organic beings present individual differences in almost " every part of their structure, and this *cannot be disputed*," —a statement containing various propositions which Mr. Darwin's opponents *do dispute*, does not promise well. The styling saltatory Evolution a " false belief " (ii., 409) lends support to suspicions.

Fourthly, the fact that Mr. Darwin repeatedly insists that variation under Nature is slower than variation under domestication raises the prospect of a large demand upon the scientific faith.

Fifthly, having found the *momentum* of Darwinism, as it were, on the wane, we could not have looked forward with confidence to its resuscitation in the instalment next following. *Natural Selection* might or might not have been fortified rather than its *rôle* minimised.

An illustration must be given exhibiting Mr. Darwin's incapacity to comprehend rival theories aright. The saltations advocated by Dr. Mivart are by him distinguished from monstrosities. These latter are coupled with " abortive and " feeble attempts at the evolutionary process." By supposing that by monstrosity " is meant some considerable " deviation of structure generally injurious or not useful to

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* Italics the *London Reviewer's* (July, 1860).

"the species" (p. 33) Mr. Darwin tacitly concurs. His remark that it is "in opposition to all analogy" to suppose that "many individuals varied simultaneously" (p. 204) shows that he conceived these saltations as analogous to what the vulgar would distinguish as natural variations. And herein a failure to appreciate an opponent's position.

Philosophical Characteristics.

The function of Philosophy is said to be the unification of knowledge; to concern itself with the fusion into more general terms of hitherto unaffiliated truths garnered from the several sciences. These latter strive to assign the phenomena encountered in their domains to what are called "secondary causes," in so doing trusting (some upon one ground, some upon another, and some upon a third) in the Persistence of Force, with its derivative truths, involving, *inter alia*, a belief that "forces, which become manifest, do "so by disappearance of pre-existing equivalent forces." The term may likewise be employed to invest with due dignity the attempt to discern the laws and purposes of interference with the Persistence of Force, assuming such ever occur or have ever occurred. The philosophy of the *Or. of Sp.* is in direct antagonism to the former, and irreconcilable with any form of the latter worthy of being entertained. Let us see why.

Whether Mr. Darwin held that Deity "created a few "original forms," alive *ab initio*, or in the "appearance or "creation" of a "few forms" or of "some one prototype" (either "considerably lower than the lowest mollusc" or only "a little lower than the angels"), with their, or its, subsequent vivification by the breath of the Creator, some force not recognised as persistent in the philosophical sense is summoned. Moreover, the creation of mere *living* beings is almost, if not quite, worthless metaphysically. When a person handles the *plant* called the nettle, quite probably that person alone *feels*,—almost certainly he alone *determines* to avoid contact henceforth. So the theory of Divine *vivification* is not needed to explain sensation or free-will. It has been affirmed that "in the production of consciousness "by physical agents acting on physical structure we come "to an absolute mystery never to be solved"; while Mr. Darwin considers free-will a typically insoluble problem (ii., 428). Deity is a bountiful mine of explanation: surely its services might have been utilised a little here!

To recur to Philosophy. Advocates of Divine interference regard miracles as factors contributing towards some *dénouement*, or as parts of some plan calculated to gratify Deity directly, or indirectly by elevating his favourite creature. Thus, though (as Cardinal Newman remarks) a sort of atheistic tendency is liable to result from the impressions which a visit to a menagerie gives of the immense variety of animal forms, colours, &c.,—for Nature seems "too strange to be the work of God, according to . . . our "contracted notions of His attributes,"—the "natural pro-"pensities and passions" of animals are such "mysterious "phenomena"; their strangeness of "countenance"; the *principle of deformity*, "whether hideousness or mere home-"liness," and the *principle of the ludicrous*, evidence an Author (according to the Cardinal), but no "Principle or "Agent correlated to our religious ideas,"—yet certain organic phenomena, as the song of birds, the colours of sea-anemones, the utility of cattle, are conceivably lines in a hymn of praise. Again, fulfilment of prophecies, miracles confirming inspired records, the endowment of each *ego* with an element of personality surviving a Judgment Day, are not, to theists, *à priori* improbabilities. Albeit the most ardent antagonist of anthropomorphism will fail to discern a performance becoming to Deity in the vivification of germs or jelly cast adrift on the world, and the differentiation of whose progeny, being "due to secondary causes, like those "determining the birth and death of the individual," betrayed what, were we criticising "mechanical inventions," we should consider "the blunders of numerous workmen." Some teach that Omnipotence rested after six days of creative labour; Mr. Darwin's Creator retired before the Tree of Knowledge blossomed.

Mr. Darwin's theistic philosophy is beyond my power of sober characterisation. Dr. Mivart remarks that Mr. Darwin, "of course, has no difficulty in finding in [a result] "what he had previously put in" the factors; but this logical feat (and it is irrelevant to the matter in hand whether or no Mr. Darwin performed it) is eclipsed by that of finding something in the result not present in the factors. By a Calvinistic chemistry a God is manufactured from blunders and sufferings, as in ordinary chemistry a salt is manufactured from an acid and a base. But we can no more exonerate God from the responsibilities of these, and credit Him with whatever of benefit happens to arise therefrom, than we can remove the Calvinist difficulty by supposing that He who ordained the end (salvation) likewise ordained the means (prayer—therefore the elect are not excused from praying), since another end (perdition) and another means (sins) are left unaccounted for.

From this logical abyss the religious views of Charles Darwin (according to a pamphlet of that title) drifted to a verbal agnosticism.

When will these blind partners, tottering Theism and capering Agnosticism, curvet together into the proverbial ditch?

Moral Characteristics.

My prefatory paragraphs questioned whether colossal intellectual achievements can condone for moral obliquity? And without discussing the propriety of humouring lunatics or answering children evasively, ascribing a literal meaning to "not at home," or judging those whose personal liberty having been restricted by the State lie to evade the law, we may stigmatise mendacity as a sin now-a-days, and subscribe to the dictum "Society cannot prosper by lies,"* whether or no we believe that the wise man may reassure himself, and fearlessly give full utterance to his innermost conviction; though it may be mentioned that one value of aggressive veracity is recognised by Mr. Darwin himself, when he says—"Whoever is led to believe that species are "mutable will do good service by conscientiously expressing "his conviction; for thus only can the load of prejudice by "which this subject is overwhelmed be removed" (p. 423).

The sin referred to is that insidious sort of mendacity known as hypocrisy, and that of an obtrusive, not of a passive, character. In the *Or. of Sp.* "Mr. Darwin writes "as a Christian, and," continued the *Quarterly Reviewer*, "we doubt not that he is one." Mr. Darwin wrote like a Christian, inasmuch as opposite the title-page he printed a quotation recommending men to obtain endless proficience in the literal "book of God's word and divinity," the piety of the quotation being enhanced, if possible, by the couple of quotations which precede it,—one being taken from a 'Bridgewater Treatise,' by William Whewell, Doctor of Divinity; the other from Bishop Butler's *Analogy of Revealed Religion*; also inasmuch as, when quoting the impression of Leibnitz regarding the law of the attraction of gravity "as

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* *Social Statics*, by HERBERT SPENCER. London, 1851, p. 471. It will be eminently fit to point out here that the paragraph concluding the 'Reconciliation' in *First Principles* (utilised in the next clause of the article) is a copy, with a few alterations, of the concluding portion of the last section but one of *Social Statics*.

"subversive of natural, and inferentially of revealed, religion," he expressed satisfaction on noting that such impressions are transient in character (pp. 421, 422); the piety of this delivery being likewise enhanced, if possible, by the context, it being preceded by the remark that "I see "no good reason why the views given in this volume should "shock the religious feelings of anyone," and followed by a sort of endorsement from a letter written him by a "celebrated author and divine."

These quotations from divines and others in defence of divinity and revealed religion, in conjunction with Mr. Darwin's own remarks, indicate that Mr. Darwin, already known as a Christian,* had not renounced Christianity prior to 1859. It happens, however, that there has been published a circumstantial account†—rendered probably true by general considerations, and also more or less confirmed in sundry letters—of a conversation held in the year 1881 at Down, when Mr. Darwin stated that he had given up Christianity when 40 years of age. Visitors to Westminster Abbey may ascertain that Mr. Darwin's fortieth birthday anniversary was a decade anterior to 1859: for in that edifice is Mr. Darwin's tombstone. It has been proposed that in that edifice a medallion be placed, purchased with a margin of the Darwin Memorial Fund not absorbed by the statue or devoted to the promotion of *biological* research in honour of the writer on Coral Reefs, Volcanic Islands, South American Geology, and the Formation of Mould.

Recapitulation.

The following is a recapitulation of the salient features of Mr. Darwin's Masterpiece, as above delineated:—

From a literary standpoint it is a half-finished work, indefinite as to primary argument, incoherent in the stating of data, and tinctured with dogmatism, *petitio principii*, discourtesy, and injustice.

The several characteristics treated under the head Scientific do not admit of sufficiently succinct recapitulation.

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* "1834, September 5th. . . . . In the evening we reached a comfortable "farmhouse, where there were several very pretty señoritas. They were "much horrified at my having entered one of their churches out of mere "curiosity. They asked me, 'Why do you not become a Christian—for our "religion is certain?' I assured them I was a sort of Christian."—*Naturalist's Voyage round the World* (pp. 262, 263). A sort of piety, too, pervades the entire book.

† *The Religious Views of Charles Darwin*, by EDWARD B. AVELING, D.Sc. Freethought Publishing Company. 1883.

Nevertheless their importance and their number are second to none.

It is characterised by incongruity with the standpoints of at least two species of philosophy, and shortcoming, if not useless, from a metaphysical point of view.

Its chief moral characteristic is mendacity, in that it is preceded and concluded by an active, as distinct from, and in addition to, a passive—by pious quotations and comments, in addition to reticence virtually endorsing an ascription of orthodoxy to its author—hypocrisy.

II. RELATIONS BETWEEN SPIRITUALISM AND SCIENCE:

MR. A. R. WALLACE AND R. M. N.

By the AUTHOR OF "SCIENTIFIC MATERIALISM."

> "Any theory, hypothesis, philosophy, sect, creed, or institution that fears investigation openly manifests its own error."
>
> ANDREW JACKSON DAVIS'S *Motto*.

AN article under this heading appeared in the "Journal of Science" (July, 1885, p. 400), by R. M. N. From many passages I infer that R. M. N. does not, as many so-called Scientists do, ignore the authentic facts of so-called "Spiritualism": the conclusions to which they lead are serious, not to say momentous. Supposing that the Spiritualistic theory be proved, there is this gain, *viz.*, that the deviations from known natural laws witnessed by many thousands of credible persons result from the *actions* of the spirits of persons once existing in this world of life, and a logical answer to that most important question the immortality of the soul of man (to use the word "soul" in its most comprehensive form) is given, and proves it without the possibility of question. If it be denied that the recorded facts result from the actions of disembodied spirits, then it must follow that, besides the phenomenal aspects of Nature, there is behind and within them an occult power tantamount to spiritual interposition. This would show that there is a world, beyond the world in which we live, inhabited by beings capable of suspending and counteracting those laws which we know as the laws of Nature. The facts, attested as they are by millions, cannot be ignored by any thinking mind. A mass of evidence is capable of being produced which is most overwhelming, and if adduced in any Court of Law, on questions of property or life, would make the verdict affirmative.

R. M. N. says—"Unwelcome as these facts may be to many of us, serious as are the conclusions to which they seem to lead, there is nothing to be gained, and possibly there may be much to be lost, by persisting in an attitude of blank sweeping denial." This, it must be admitted, is a fair statement, and it is much to be regretted that the prominent men of Science, who assume to lead public opinion, have not fairly met the facts presented to their consideration. The treatment experienced by Dr. Slade, at the hands of Dr. Lankester and his coadjutor, was a gross persecution: subsequent events show that the acts of spirits (as he assumed) are far exceeded in the particular exemplification which he attempted.

It must be admitted that charlatanry is present at many *séances*; but this must be attributed rather to the wonder-mongers than to the mediums, who, in their desire to gratify the wonder-seeking crowd, have endeavoured to simulate the real facts in order that they might not go away disappointed. It is patent to frequent visitors of *séances* that the power which usually attends mediums is not always present, or, if present, not always active. Mediums are but human, and it is easily to be understood that when impelled by their cupidity they are not always in that frame of quietude and passiveness which is absolutely necessary for the presentment of the manifestations. I may say that rarely convincing manifestations are obtained from a mixed class of paying attendants. This may be said, that any person really desiring proofs is seldom disappointed.

So far as my personal experience is concerned, the few presentments of which I have been a witness have led me conclusively to believe that there was an *extra mundane power active and present*. I hesitate to say that what I witnessed was the work of spirits, but to what other occult power it is to be assigned I am at a loss to determine. One well-attested fact is as conclusive as a thousand: two I witnessed placed the matter, to my mind, beyond doubt.

First.—A letter lock, of eight letters, which had been purposely deranged, was opened by Mr. Conklin. The person who, after deranging the lock, wrote what he conceived to be the opening word, enclosed it in a sealed envelope, but which proved to be wrong in one letter. The lock was given to Mr. Conklin, the envelope delivered to persons who were appointed as judges. The solution given by Mr. Conklin was the correct word, and the lock was opened; the word written in the envelope failed to effect its purpose. The whole transaction was so arranged that it was impossible that there could be any tampering either with the envelope or lock.

Second.—I accidentally called upon Mr. Conklin: whilst with him two gentlemen enquired whether Mr. Conklin would grant them a sitting. They were introduced, and stated that they were strangers in New York and had just arrived; having heard of the spiritual movement they were (if possible) desirous of testing it. Mr. Conklin acquiescing I rose to leave (fearing that the visitors might think there possibly might be collusion between myself and the medium). Mr. Conklin wished me to stay, the sitters joining in the request; I did so. The *séance* was arranged: one, the questioner, asked if it was necessary to frame the questions in English, or might he communicate in another language? Answer: the language was a matter of indifference; the answers would be in English. The tests were knocks and writing. The questions were framed, in number I think twelve. As they were written they were placed, one at a time, face downward, before Mr. Conklin: he, being apparently in a semi-somnolent state, wrote the answers in English, seriatim, as placed before him. The answers were stated by the questioner to be exact answers, and such as he should have expected in a *vivâ voce* conversation. The questions were written in Welsh, and addressed to his wife, who had been dead twenty years, with whom he wished to communicate. He stated his conviction that he had had communication with the spirit of his deceased wife, and that the questions were upon subjects known only to himself and to her.

I must apologise to the Editor for presenting such matter for insertion in his Journal. Viewed as a philosophy, or as an analysis of facts, all objection should be waived. The narratives are couched in the baldest form, and presented to show that by no possibility could they be supposed to be mere *mind* reading—the usual subterfuge of doubters. In the first case such an assumption would be ignored, the word enclosed in the envelope being incorrect; in the latter case Mr. Conklin was ignorant of Welsh, and it might almost be said of any other language, his diction when in his normal state being most irregular. He was almost uneducated, and had been a common sailor; but when under influence his language was free, and the words correctly spelt.

R. M. N. appears to think that the "new revelations" are mischievous in character, and by possibility will subvert every existing order of things, as he says—

> "Cast on all things surest, brightest, best,
> Doubt, insecurity, and astonishment."

This is far from my idea, for they give an assurance and reality, much wanted, which no other manifestation could satisfy; they afford evidence of other intelligences than those existing in the world's life, and present almost tangibly those of a world to come. I quite agree with R. M. N. that there is much to learn and probably much to gain, and, further, that the scientific world has proved itself most unscientific in ignoring presentments because they do not accord with the assumptions of the scientific mind. Whether Science and Spiritualism will ever harmonise there is much room to doubt. Science has its purview of phenomena with the rigid requirement of exact law; but of the inner movements of that interior something which all men possess, developed or undeveloped, of its laws they know nothing. The Christian Church has existed for nearly two thousand years, and finds the World more ignorant of and unbelieving in Spiritual matters than it was on its institution. Exactly what occurred in the early Church was experienced in the Spiritual movement. The Church contained an idealism which, rightly directed, would have advanced the human race. Spiritualism, on the other hand, without idealisation, without dogma, presents its array of facts which properly considered would lead to the same end. No, Science and Theology are both in arms. Science resists because there are no apparent laws by which the movement can be directed or controlled: Theology rejects the friend which would lead to the development of those truths of which it considers itself the patron and promoter.

If Spiritualism, or the manifestations so called, were isolated facts, and confined to one family or to one nation, a halt might be made; but when America, Europe, and Asia present the same evidences, it then becomes a common question.

Colonel Churchill, in his work on Mount Lebanon, under the head of "Magic," gives an account of some manifestations occurring there. The statement is evidently that of an eye-witness, or of one who had examined the evidences and satisfied himself as to the facts. He says (vol. i., p. 164 *et infra*) "The son of Sheik Bechir is one of the best informed of the Druse Sheiks, and has acquired a store of history and literature which makes his conversation in every way superior. He has for some years devoted his time, singular as it may appear, to the cultivation of magic, and the stories he relates of his interviews with immaterial beings are novel and startling. At times he will place a jug between the hands of two persons sitting opposite to each other, when, after the recital of certain passages taken indiscriminately from the Koran and the Psalms of David, it will move spontaneously round to the astonishment of the holders. A stick at his bidding will proceed unaided from one end of the room to the other. A new testament, suspended to a key by a piece of string, will in the same way turn violently round of itself. On two earthenware jugs being placed in opposite corners of the room, one being empty, the other filled with water, the empty jar will, on the recital of certain passages, move across the room; the jar full of water will rise of itself on the approach of its companion, and empty its contents into it, the latter returning to its place in the same manner as it came. An egg boiling in the saucepan will be seen to spring suddenly out of the water, and be carried to a considerable distance. A double-locked door will unlock itself. There cannot be a doubt that an unseen influence of some kind is called into operation, but of what nature those may conjecture who like to speculate on such matters."

"But it is in more serious cases of disease or lunacy that his supernaturally-derived powers are called into play. Previously to undertaking a cure he shuts himself up in a darkened room, and devotes his time to prayer and fasting. Fifteen and sometimes thirty days are passed in this state of abstinence and self-denial. At last one of the genii, described by him to be much of the same appearance as human beings, will suddenly appear before him and demand his bidding. He then states his position, and requires assistance in the case he is about to undertake. The genii replies at once that his request is granted, and encourages him to proceed." A lady who had been for more than two years afflicted with a swelling, which had long been mistaken for pregnancy, was cured by the passage of his hand over her person, "and in five minutes she arose perfectly cured." A confirmed lunatic was brought before him; "in two days he returned to his home perfectly cured."

The Sheik "maintains his intercourse with spiritual agents to be real and effective." "The belief in Magic, and in the interposition of an order of unseen creatures in worldly affairs, at the bidding of those who choose to devote themselves earnestly to such intercourse is universal throughout the entire population of every religion and sect."

"Instances could be multiplied in which most extraordinary and unaccountable results have been brought about, by the intervention of individuals who make this communion the subject of their study and contemplation."

R. M. N. demands the same mode of investigation for spiritual facts as for phenomenal facts. He says Science is based *on law*, Spiritualism *on will:* supposing this to be the fact, is he in a position to state that *this will* is not restrained by law? Exactly what he claims for phenomenal manipulations the Spiritualists claim for their manifestations. He states that *under certain circumstances* Science can "foretell phenomena," and that wherever the experiment is made "the result comes out the same," and "*that under the same conditions the same results will follow.*" We have then a qualification—"There are of course numbers of cases in which the causes and conditions of phenomena have not been traced out." Now this is, as I understand it, exactly the Spiritualist's position: they have numberless facts, phenomena if you will, but know of no law or mode for the classification of them, nor has ever the attempt been made to find a law or apply a classification. It has never been presented as a Science, but merely as a succession of manifestations which appear to evade all scientific rules. Being so, it seems scarcely fair, except so far as the evidences of the facts, for Science to demand that the manifestations—which appear to subvert all scientific principles and to obey no scientific law—should be subjected to an exact formula. It should be remembered that the manifestations cannot be produced at will, as physical or chemical combinations may be, but are the result of peculiar conditions. Some of these conditions are widely spread, others but rarely occurring.

All Science has the right to demand is that the evidences of the facts are unimpeachable, and ought not to be greater—and ought not to be required to be greater—than those which would establish a case if presented before a legal tribunal. There should be no saying, after the investigation establishing the fact, that it is impossible because contrary to the so-called laws of Science or of general experience.

Let Science fairly collect the facts (manifestations), give them fair treatment, and then, if it can, find the law by which they result. If, as surmised, the manifestations are *super mundane* in character, no secular law will fathom them. This at least may be said—that the manifestations have never subverted physical phenomena detrimentally, and have never intervened to produce social difficulties, and therefore they would appear to be amenable to some law of which those who witness the evidences are unconscious.

It is quite futile to talk of will in connection with the manifestations. A person might will for ever; unless the conditions were quite accordant and present he could not float in the air as Mr. Home and others have done.

At page 403 R. M. N. cites many manifestations, but does not show that any evil has followed: it therefore follows, whatever be the power manifested, that it is subject to restraint. It will be quite time enough, when any of the evils R. M. N. appears to anticipate occur, to ascertain "what are the limits of the powers of these 'Spirits,' and under what conditions can they be exerted?"

He says "this question has its moral aspect." Œrsted had in his mind a different class of manifestations to those termed Spiritual. The evil of Witchcraft was not its spiritual aspect, but the malevolence and ignorance of uneducated or theologically superstitious people. Assumptions were made which in no case were verified, and many were the victims to the intolerance of public opinion. There is no similarity in the facts, and can be no evidence, moral or otherwise, for or against Spiritualism.

(To be continued).

III. IGNORAMUS ET IGNORABIMUS.

WE call Science the interpretation and the comprehension of the Universe. Yet considerations to which we cannot close our eyes force us to own that the interpretation is vague and arbitrary, and the comprehension in the very last degree fragmentary. It is well to reflect how much in our systems is taken for granted without proof, and how very narrow are the limits of our knowledge. Indeed " narrow " is not the correct term. We can nowhere draw a boundary line and say that everything within such line is clearly understood, and that our knowledge of it is brought into an organic, and therefore harmonious, co-ordination. The unknown and the unknowable intersect, and even underlie, the known. In the memorable discourse from which we have taken the title of our present reflections it is shown that we can no more understand the origin and the nature of matter than that of life and feeling. Here, surely, we have too wide and bottomless chasms beneath the very foundations of our knowledge. True we may ignore these chasms, trying to persuade ourselves, with Comte, that Science does not concern itself with origins and natures. The world does not accept this self-imposed restriction. It taunts us, more or less explicitly, with our ignorance. It tells us that we do ill to dogmatise on the attributes of matter when matter itself is all the while an unguessed riddle. Nay, do we not find ourselves half unconsciously trying to explain the origin of life, of irritability, and of consciousness?

But there are other gaps and crevices in our systematised knowledge which we cannot in any manner ignore. Dismissing all enquiry as to origins and as to underlying noumena, we may adhere to phenomena, the impressions which we receive through our organs of sense. We may, as in fact it is done in all research, postulate that these impressions, if not faithful transcripts of things *per se*, bear to them a constant and definite relation. This is a strong postulate. But letting that pass, we remark the very limited number of our avenues to knowledge. In common opinion we have but five; and even if we admit a heat-sense as distinct from touch or the general apprehension of resistance, and a magnetic sense, it is still unwarrantable to suppose that we obtain through these scanty loopholes a complete view of the universe. Had we a greater number of senses, should we not receive impressions of which we have now no more conception than a man born blind has of light and colour? Would not the information thus received greatly modify our present knowledge? To understand this point the more clearly, let us suppose a set of beings possessing the same intellect as do we, but devoid of hearing. The effects of this shortcoming on their means of social intercourse we are not going to discuss. But if incapable of hearing they would never have observed the properties of sound, and in consequence they would not have had their attention called to vibrations as the cause of sound. Under these circumstances it is not too much to say that the undulatory theories of heat and light would never have suggested themselves to the physicist. What a complete change in our Science, therefore, would the absence of this one sense—one of the senses least used in the direct interpretation of Nature—involve!

Or let us suppose a set of intellectual beings sightless, like certain insects in the caverns of Carniola and Kentucky. Being blind the discipline of optics would for them have been, of course, non-existent. The part played by light in the organic world would utterly escape their observation. Astronomy would be inconceivable, and no theory of universal gravitation could have been evolved.

Or, again, imagine scent and taste, generally regarded as the humblest of the special senses, wanting. The ideas of acidity, alkalinity, and of neutralisation would never have arisen, and in their absence the foundations of chemistry could not have been laid.

Thus we see that, if any of our present senses were wanting, entire categories of phenomena would escape us, and that entire branches of Science as we have them could never have arisen.

Such being manifestly the case, is it not justifiable to assume that, had we more senses, more gateways of knowledge, we should become cognisant of classes of phenomena which have now for us no existence, and that new unimagined sciences would be developed? A little reflection will convince most of us that the additional knowledge thus gained would in many cases inevitably modify our present views.

But it may be said—and will be said by many in full conviction—that an increase in the number of our senses is impossible. Just as rationally would it be said by a blind, or deaf, or smell-less race of people, could such be found, that *their* number of senses was the maximum possible. But we may easily show that many additional senses are perfectly within the range of possibility. We all, in these days, hold that not merely sound, but light and heat are due to vibratory or undulatory motion. So be it: the vibrations which impress us as sound are at the rate of not more than 20,000 per second. But the slowest of the vibrations which impress us as light are after the rate of 400 millions per second. As it has been pointed out by Prof. Pierce, of Cambridge (U.S.A.) between these two limits there is room *for more than forty additional senses*, each of which might convey to the sensorium of an animal a totally distinct set of impressions. That we are not provided with organs upon which such vibrations can react is surely a very lame proof of their impossibility. Some persons suspect that certain insects may possess one such sense, if not more than one. Others raise the insoluble question whether additional organs of sense may not be evolved in man either in coming generations or in a future state of existence. But such speculations are for the present idle. We can no more form any distinct idea of a number of new senses than we can of *n* dimensions in space.

This, however, is totally wide of our immediate purpose. Unless we are prepared to deny the possible existence of such senses we must admit that our present insight into Nature is most fragmentary. We are like men gazing upon a nocturnal landscape upon which fall five narrow beams of light from the windows of a castle, leaving broad regions between them unilluminated. What these dark spaces may contain it is impossible for them to say; but they will be presumptuous in the extreme if they venture to assert that they have a complete view of the entire region, that they see all which does exist, and that whatever they fail to see is "impossible." Yet this is exactly the position which men of great reputation have not unfrequently taken. Hence true men of Science, fully alive to the responsibilities of their position, are now very reluctant to pronounce on "impossibilities."

But there is no occasion for us to indulge in conjectures concerning the possible information which might be conveyed to us by other senses if we had them. Those which we do possess fall very far short, each in its respective sphere, of giving us complete information. Let us look first at the most highly developed of all, our light-sense. Every tyro in optics knows that the retina of the human eye does not react to *all* the solar radiations. At both extremities of the spectrum there are rays, invisible to us, the ultra-red and the ultra-violet. We can demonstrate their existence by certain artifices. It is highly probable that they—at least the ultra-violet—produce impressions on the eyes of certain insects, but so far as they are concerned we are blind. Now if those rays affected our eyes it may be regarded as certain that we should see objects not precisely as we now see them, but more or less modified. This will appear the more manifest if we reflect that fully one-third of the solar radiations do not act upon our retina at all.

This consideration not unnaturally connects itself with the question of colour-blindness, which has been so ably examined in our columns by Mr. Jabez Hogg. Is this defect—which in the sufferer very much narrows, or, at all events, renders less precise the information received through the light-sense—increasing or decreasing in frequency? In the latter case, is it not at least conceivable that a time may come when the sensibility of the retina shall be extended?

But besides the quality of the solar radiations, their quantity also fixes a limit not ordinarily passed, to our power of sight. Many animals can see where we cannot see at all, or see only with the greatest difficulty.

It will perhaps be contended that an inability to recognise very feeble lights can make little difference to our insight into the phenomena of Nature, since if objects are invisible to us in the night we may revisit them in the day, or we may make use of artificial lights. But what if, as certain facts lead us to suspect, numbers of plants and animals emit phosphorescent light, too faint for us to recognise! Here a greater acuteness of sight would open to us quite a new world.

Passing from sight to hearing, we again meet with evidence of the imperfection of our senses, and the consequent incompleteness of their teachings. There are sounds too deep to impress our auditory nerves, and others again too acute. Of the existence of the latter, at least, we are convinced by the varying range of the sound-sense in different individuals, whilst certain insects appear affected by vibrations much more rapid than any which to us produce an audible sound. Hence in pronouncing any animal species "mute" we are possibly in error. It may have the means of producing sounds which simply do not fall within our compass of hearing.

Another human shortcoming is our limited ability to determine the direction of a sound and the distance of its origin. We may often witness among human beings a discussion as to whether a sound proceeds from a point to the right hand or to the left, in front or behind. Few of us but must, on reflection, admit that we have often been deceived in attempting to localise a sound. But in all the observations which we have made upon cats and dogs, we have never seen them thus mistaken. Let anyone scratch with his nails on the underside of a table at which he is sitting: if there is a cat in the room she will not listen in various directions, as if seeking. She will at once turn her eyes and ears to the precise spot, even if she cannot have seen the least movement of his hand or arm. Had mankind this faculty many phenomena would be more accurately traced to their sources, and certain superstitions might possibly never have arisen.

But our greatest shortcoming, both as compared with other animals and with what there is to be known in this direction, is in the sense of smell. The scent of the bloodhound is commonly held up as a type of acuteness. But far more striking is the scent of certain moths. A male emperor moth (*Saturnia carpini*) recognises the presence of a virgin female of his species at distances exceeding a mile, with woods, fences, hills, or houses intervening. This is far more striking than the faculty of the dog, which merely finds out the object of its pursuit by following its trail, whilst in case of the moth there is no trail to follow. We are apt to wonder at the delicacy of the spectroscope, but here are reactions millions of times more sensitive.

Now we have no science of odours. We detect a few of the more prominent, though even there we fail to recognise their mutual inter-relations. But had we such an odour-sense as the emperor-moth we should be able to diagnose animals, plants, minerals, and artificial compounds in general by their smell. We should by this sense be informed accurately and minutely concerning decompositions, fermentations, and putrefactions in dead matter, and concerning changes, physiological, pathological, and even in some cases psychological, in the living. Physics, and still more chemistry and biology, would be enriched and modified to an extent and in a manner which can be but very imperfectly shadowed forth.

All these considerations show us how very imperfect and fragmentary is the primary material upon which Science has to work. Entire categories of phenomena escape us. What would be the position of our bookworms if, in the ancient treatises in which they delight, letters, words, sentences, and chapters, in great numbers, were here and there missing? What if they were not aware of the very existences of such gaps and deficiencies, but believed that they had before them the complete text, and proceeded to expound it accordingly? Misinterpretation, surely, of the wildest character would result. Yet the position of us interpreters of Nature is but too closely analogous. With our few—and, as we have just called to mind, imperfect—senses much fails to reach our understanding. Much? Possibly in some directions the most important part. Surely, therefore, we should take good heed not to talk of impossibilities. Remembering that we see only in part, we should not be hasty in rejecting any new light which is offered for our acceptance.

IV. ON THE ARCHÆOPTERYX.

DR. W. DAMES has published a monograph on the Archæopteryx in the "Palæontolog. Abhandlungen," which has been in part reproduced in the "Neues Jahrbuch für Mineralogie," and in the "Naturforscher."

Since the first discovery of this creature, "half bird and half lizard," in the year 1861, the recent find in the Pappenheim quarries, in 1877, has called up the liveliest interest. Men of Science have been concerned about the systematic position of the animal, whilst outsiders have been exercised over the enormous price paid for so insignificant-looking a specimen. Hence this fossil had become famous before its thorough description by Dames, and the facts observed have received very various interpretations.

As soon as the attempt is made to generalise an observation, and to infer broader points of view from a single case, the most conflicting conceptions are put forward, which quickly again disappear. A beginning was made in this direction by C. Vogt. As the result of his observations the skeleton of the Archæopteryx was more that of a reptile than that of a bird. As far back as 1881, however, Seeley refuted Vogt's assertion of the reptilian character of the species, and assigned to it an especial position as the type of a peculiar family of sauroid birds. In the same year Marsh pronounced Archæopteryx as the most reptile-like bird, but considered that the earliest, most primitive, birds must be sought in the Palæozoic formations. In 1882 Dames, as he succeeded in extricating the specimen from the slab of stone, commenced his publications. He showed that a mass which Vogt had taken for bone was merely a portion of the rock. Two years later appeared his first, purely objective, description of the animal, which he regards not as a connecting-link between reptile and bird, but as a true bird, which has advanced so far in its development that it can even be assigned to a particular division of the birds, —the Carinates.

This result has been carefully worked out in the different parts of the skeleton. In the head we observe a feature peculiar to adult, recent birds, a coalescence of the frontal and parietal bones enclosing the skull. The cavity of the skull is filled with calcareous spar. The brain, as in birds now living, lay chiefly behind the orbital apertures. Not until the author had laid bare a nostril of a long, elliptical form, with pointed ends, could he succeed in bringing the several bones of the skull into harmony with those of other birds. The uncovering of the toothed beak must be regarded as a master-piece of preparation. The series of teeth is laid free to the very point of the beak, and affords a beautiful view. There are twelve teeth of almost equal size, about 1 millimetre in length, cylindrical in shape, and becoming abruptly acuminate close below the point, the edge of which is turned inwards. The teeth are not fixed as in a groove, as in Hesperornis, but each in its especial socket.

Not merely the entire head is bird-like, but the vertebral column, all the cervical and dorsal vertebræ of which have been found as far as the atlas. Those joints which carry no ribs, or only short ones, are regarded as cervical. The neck, as Vogt remarked, agrees with that of a pigeon. Dames considers that it comes to an end where the curvature of the vertebral column ceases, and where no more ribs are visible. If this is correct the Archæopteryx has twelve dorsal vertebræ, which, except the last, carry ribs. One of the most peculiar phenomena in this species are the fine, delicate, points of the ribs, which Vogt compares with a surgical needle.

Dames has also succeeded in laying bare the shoulder-bones. Vogt regarded a smooth brownish mass of stone as the coracoid and the sternum, and drew premature conclusions as to their reptilian character, which are all set aside. The entire anterior extremity, upper arm, fore arm, down to the three free metacarpal bones and the three free fingers, are simply avian. Bird-like is also the foot of the Archæopteryx, consisting of four toes, the number of joints increasing by one each from the first to the fourth. All four toes terminate in claws, the first being turned backwards and the other three forwards.

For the position of this animal in the system the skeleton is of less importance than the well-preserved coating of feathers, which can be plainly recognised on the anterior extremity, the base of the neck, the tibia, and the tail. In the wings there can be counted on each side seventeen quill-feathers, six or seven of which were fixed to the hand and the remainder to the ulna. The feathers are constructed on the type of the now-existing Carinates. It is extremely probable that the entire skin of the bird was covered with feathers, as all authorities who have examined the subject are agreed with the exception of Vogt.

Archæopteryx is by no means an animal occupying an intermediate position between birds and reptiles, but a quite decided bird, belonging to a class in which *the anterior extremity is not yet exclusively used for flight.* For the separation of the two classes the author regards the appearance of feathers as the decisive point. Though the first rudiment of the feather decidedly represents the reptilian scale, it is soon developed to an organ which protects against cold, and thus is effected the separation of the cold-blooded reptiles from the warm-blooded birds, although the common origin of these two classes cannot be doubted.

The memoir calls for a few remarks. If the Archæopteryx, as Dames maintains, belongs to the Carinates, Prof. Huxley's class "Saururæ," founded for the reception of this sole species, must be abandoned.

But, taking the very facts stated by Dames, we cannot help admitting that Archæopteryx, though clad in feathers, still retains certain important reptilian characters which in the course of evolution have disappeared from existing birds. The first of these is the occurrence of true teeth, bedded in distinct sockets. The second character is put plainly forward in the words which we have italicised, "the anterior extremity is not yet exclusively used for flight." The third is a point which Dames does not mention in his interesting memoir, but which he does not deny either explicitly or by implication, *i.e.*, the lizard-like tail composed of several vertebræ.

Hence therefore Archæopteryx, whilst possessing a feathery coating, and whilst agreeing with the true birds in the structure of its skull and limbs, exhibits at the same time at least three distinct and not unimportant reptilian features just enumerated. It is surely not easy to see by what right we can refuse to such a creature the intermediate position which it has generally received.

V. SEWAGE PRECIPITATION AND THE A B C PROCESS VINDICATED.

WHEN a man has been formally convicted of crime, with all the due solemnities involved, scarcely the most absolute demonstration of his innocence will afterwards suffice for the rehabilitation of his character. Let the perjury of the witnesses, the stupidity of the jury, and the prejudice of the judge be brought ever so clearly to light, and let the unfortunate victim receive—according to farcical custom—a gracious pardon for an offence which he never committed, a part of the British public will still look at him askance and insinuate that there must have been "something in it."

Very similar is the case when a process, an invention, or what you will, has been condemned by a Commission, Royal or Parliamentary. We cannot, indeed, fairly accuse such bodies of stupidity. More commonly they are too clever by half. But being at once judges, jury, and counsel, and having the option of rejecting all evidence which does not square with their preconceived notions, they reach, or at least publish, the most amazing and the most baseless conclusions. Of course the truth ultimately comes out. But, even then, succeeding Commissions will solemnly repeat the exploded utterances of their predecessors. Of all this a most striking—perhaps the most striking—instance may be found in the Reports of the whilom Royal Rivers' Pollution Commission. On the strength of an investigation made in a very perfunctory manner, under demonstrably unfavourable circumstances, and of an experiment conducted, to say the least, carelessly, an important process for the purification of sewage by precipitation—the so-called "ABC process"—was brought into contempt.

It was solemnly asserted by the Commissioners that "after treatment by this process the effluent sewage is very little better than that which is obtained by allowing raw sewage to settle in subsidence-tanks"; that it "removes only a very small proportion of the soluble polluting matters from sewage"; and that "the manipulations required for the extraction and drying of this manure are attended with a nauseous odour, especially in warm weather, and would occasion a serious nuisance if the works were situate in or near a town." It would, perhaps, not be easy to select three propositions dealing with matters of fact which deviate more widely from the truth. They stand out, indeed, as psychological curiosities, and we cannot but feel some little interest as to the mental—rather than chemical—processes by which men of standing and repute could bring themselves to pen such statements. They have been fully and flatly contradicted by every chemist and sanitary engineer who has taken the trouble to examine for himself. The late Mr. Keates, chemist to the Metropolitan Board of Works, who watched the process closely for three months, Dr. R. Angus Smith, Dr. Wallace of Glasgow, Dr. Letheby, Mr. J. A. Wanklyn,* besides a number of eminent medical practitioners, engineers, municipal officials, &c., most distinctly deny the propositions just quoted.

The assertion that the effluent is little better than the result obtained by allowing sewage to stand in subsidence-tanks simply excites the derision of all who have ever seen—and smelt—sewage which has been thus left to itself. It is too glaringly false to need, or even admit of, discussion.

As regards the third assertion the case is perhaps even worse. Of the numbers of people who have visited the Aylesbury Sewage Works, how many have observed the "nauseous odour" of which the Commissioners complain? Yet these visitors could probably detect a nuisance, if there were one to detect, as readily as Professor Frankland or his coadjutor.

Speaking advisedly, and keeping well within the mark, we feel free to say that it would be easy to find one hundred men, of education and position, who would be prepared formally to deny the charge of the "nauseous odour." These men are not shareholders or officials of the Native Guano Company, and have, in short, no personal ends to serve.

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* One chemist of the highest standing I omit, as he was for some time Chairman of the Native Guano Company.

Now let us suppose the question of a nuisance brought before a Court of Justice. Two individuals, having had comparatively scanty opportunities of observation, depose to the existence of a nuisance. One hundred others, many of whom have had better opportunities of observing than the two just mentioned, and opportunities extended over a much longer time, depose that there is no nuisance. We need not waste time by saying what, in such a case, the decision of the Court must be.

Now we do not pronounce the ex-Commissioners guilty of conscious and deliberate falsehood. We can readily believe that fifteen years ago, in the infancy of the process, and under the very unfavourable circumstances existing at Leamington, an odour might have now and then been detected which to the noses of strongly prejudiced persons might seem "nauseous."

But the public has good reason to complain that the ex-Commissioners and their friends, in the very face of the overwhelming opposing testimony, still continue to repeat these "conclusions." What is worse, these conclusions are rehearsed with a most Arcadian simplicity in the Second Report of the "Royal Commission on Metropolitan Sewage Discharge" (§ 161). We believe that if Prof. Frankland had, in his private capacity, made fifteen years ago a statement concerning the efficacy of any given process, and found that it was continually and completely contradicted by men of scientific standing equal to his own, he would feel in honour bound to ascertain whether the circumstances of the case were still the same as in the year 1870. Even if he did not retract or qualify his old conclusions, other persons would not repeat them with unquestioning faith. But it seems that a statement made officially, however baseless it may be subsequently found, cannot be withdrawn, and must still pass for truth in official circles.

It is interesting here to notice that the recent Royal Commission on Metropolitan Sewage Discharge did not take a step to ascertain whether Prof. Frankland's archaïc conclusions are at all applicable in our day. A journey to Aylesbury would have resolved these conclusions into nothing. But a forty miles' journey to see whether these things really are so, is, we presume, too much trouble to face in the interests of truth.

It is therefore fortunate that the publication of the Report of this Commission has indirectly served to bring out a fresh body of evidence, which ought to do away for ever with the "conclusions" of the Rivers' Pollution Commissioners and of their echoes.

Prof. Dewar, F.R.S., and Dr. Tidy applied for permission to make a thorough investigation into the details. Their request was granted, and early in the present year they began their researches. It must be distinctly understood that they were not in any way commissioned or instructed by the Native Guano Company. They were working for their own satisfaction, that they might be able to tell the public the truth on a most important question. Hence they were under no temptation to prophesy smooth things to the Native Guano Company.

Another important point is the minute and continuous character of their scrutiny. For three consecutive months, whilst the process was carried on in the usual manner, the Works were placed completely at their disposal. Personally, or by a qualified and very skilful assistant, they were present daily, and had full liberty to examine the sewage, the effluent, the deposit, and the materials used, when, where, and how they pleased. This was a scrutiny much closer and more rigorous than that of the ex-Rivers' Pollution Commissioners at Leamington, or even than that of the late Mr. Keates at Crossness.

Prof. Dewar and Dr. Tidy express their formal opinion that "isolated observations on the composition of a sewage and of an effluent have no real value in testing the efficacy of a sewage process"—a view in which we most fully concur. They add—"Considering the fact that the strength and composition of the sewage change so rapidly and frequently, it is manifest that conclusions deduced from a few observations are *worthless, and often misleading*." Hence they made three series of experiments, each continued for twenty-four consecutive hours. Samples of the raw sewage and of the effluent were collected every half hour, and equal portions of four successive half-hourly samples were mixed together for analysis.

These three series of sampling were purposely carried out under different circumstances, as regards rainfall and character of sewage. It was the object of the inquirers to test the process under the most varying conditions, and see if it at any time failed to answer the purpose.

The first series of samples was collected from 8 a.m. January 29th to 8 a.m. January 30th. The flow of sewage was abnormally large, and it was consequently very dilute. The suspended matter was only 18·8 grs. per gallon.

In the second series, from 8.30 a.m. March 2nd to 8.30 a.m. March 3rd, the flow was still large, but the strength of the sewage was much greater, being on the average 59·97 grs. per gallon.

The third series, from 8.30 a.m. March 16th to 8.30 a.m. March 17th, was taken in very dry weather, the sewage being abnormally rank. The suspended matter was 243·6 grs. per gallon.

In all these cases the action of the process was found successful. Prof. Dewar and Dr. Tidy express their opinion that beyond all doubt "the A B C process is capable of producing a uniform effluent, notwithstanding the very varied nature and concentration of the raw material to be dealt with." They find that, irrespective of the original sewage, an effluent can easily be obtained practically clear,—that is, "*containing less than one grain of suspended matter per gallon*," though the raw sewage contained a mean amount of 104·4 grs. per gallon. Further, "The precipitation appears to be more complete as the quantity of suspended matter in the raw sewage increases.

But it may be said, What of the dissolved organic impurities, always recognised as the most important? Here we find it stated that in the three series of experiments the percentages of dissolved organic matter removed were respectively 74·80, 83·30, and 86·30! This, we submit, is a very different conclusion from the rash statement of the Rivers' Pollution Commissioners that "the process removes a *very small proportion* of the soluble polluting matter from sewage."

Nor is this all. Messrs. Dewar and Tidy find, on careful examination, that at least two-thirds of the organic matter remaining in the effluent is diffusible, and therefore cannot be "of an albuminous or complicated colloidal nature." Hence it is less liable to putrefactive changes. It is, in the opinion of Prof. Dewar and Dr. Tidy, "mainly composed of the salts of fatty acids and such like bodies."

Here, then, we have the first two of the Commissioners' conclusions very fully exposed and disposed of. If, by "allowing raw sewage to settle in subsidence-tanks," they can obtain in a few hours an effluent very nearly as good, the sooner they prove it the better for their own credit.

The third "conclusion" of Prof. Frankland and his colleagues was that "the manure obtained by this process has a very low market-value, and cannot repay the cost of manufacture."

Prof. Dewar and Dr. Tidy find, on the contrary, that the dry manure contains nitrogen equal to 3·8 per cent of ammonia (consequently equal to 19 per cent sulphate of ammonia), and phosphoric acid equal to 5 per cent of tricalcic phosphate. These figures will be better understood if we remember that farmyard manure, in its normal condition, contains only 0·40 per cent of nitrogen, or when absolutely dry 1·95 per cent (= 2·36 ammonia or 11·80 sulphate of ammonia) and 0·18 phosphoric acid (= 0·37 per cent tricalcic phosphate). Surely a manure containing nearly twice as much ammonia as farmyard manure, and more than ten times as much phosphoric acid, is not to be despised!

Lastly comes the fourth conclusion of the Commissioners, that "the manipulations required for the extraction and drying of this manure are attended with a nauseous odour, especially in warm weather, and would occasion a serious nuisance if the Works were situate in or near a town."

On the contrary, Prof. Dewar and Dr. Tidy say—"The sewage is completely and immediately deodorised, no escape of offensive odours from the sewage into the surrounding air taking place. *The entire Works are, in our experience, free from any objectionable smell whatsoever.*"

The investigation conducted by Prof. Dewar and Dr. Tidy is both more precise than that carried on by the late T. W. Keates, F.C.S., at Crossness, in 1872, and the results more satisfactory. Mr. Keates pronounced the effluent water as "on the whole very good." He declared himself to be "of opinion that such water was in a fit state to be admitted into any ordinary river without producing a dangerous degree of pollution." But with commendable caution he pointed out the extremely dilute state of the sewage during the experiment, and remarked that it was "of course impossible to say, at least from this experiment, how far the A B C treatment would defecate sewage of a stronger character."

In this respect Prof. Dewar and Dr. Tidy have been more fortunate. They have encountered sewage much stronger and ranker than any which Mr. Keates ever witnessed at Crossness, and they have found and declared that the A B C process is competent to defecate such liquids.

The question now only remains, How often and how authoritatively the truth must be reiterated before it will be accepted, and before the misstatements of the Royal Rivers' Pollution Commission fall into the discredit due to their character?

VI. ON THE CHEMICAL ACTION OF LIGHT.

PROF. A. VOGEL, in a communication to the "Sitzungsberichte der Münchener Akademie," brings into prominence the fact that the hemlock plant which yields coniine in Bavaria contains none in Scotland. Hence he concludes that solar light plays a part in the generation of the alkaloids in plants. This view is corroborated by the circumstance that the tropical Cinchonas, if cultivated in our feebly lighted hothouses, yield scarcely any alkaloids. Prof. Vogel has proved this experimentally. He has examined the barks of Cinchona plants obtained from different conservatories, but has not found in any of them the characteristic reaction of quinine. Of course it is still possible that quinine might be discovered in other conservatory-grown Cinchonas, especially as the specimens operated upon were not fully developed. But as the reaction employed indicates very small quantities of quinine it may be safely assumed that the barks examined contained not a trace of this alkaloid, and it can scarcely be doubted that the deficiency of sunlight in our hothouses is one of the causes of the deficiency of quinine.

It will at once strike the reader as desirable that specimens of Cinchonas should be cultivated in hothouses under the influence of the electric light, in addition to that of the sun.

If sunlight can be regarded as a factor in the formation of alkaloids in the living plant, it has, on the other hand, a decidedly injurious action upon the quinine in the bark stripped from the tree. On drying such bark in full sunlight the quinine is decomposed, and there are formed dark-coloured, amorphous, resin-like masses. In the manufacture of quinine the bark is consequently dried in darkness.

This peculiar behaviour of quinine on exposure to sunlight finds its parallel in the behaviour of chlorophyll with the direct rays of the sun. It is well known that the origin of chlorophyll in the plant is entirely connected with light, so that etiolated leaves growing in the dark form no chlorophyll. But as soon as chlorophyll is removed from the sphere of vegetable life, a brief exposure to the direct rays of the sun destroys its green colour completely.

Prof. A. Vogel conjectures that the formation of tannin in the living plant is to some extent influenced by light. This supposition is supported by the fact that the proportion of tannin in beech- or larch-bark increases from below upwards, — that is, from the less illuminated to the more illuminated parts, and this in the proportions of 4 : 6 and 5 : 10.

Sunny mountain slopes of a medium height yield, according to wide experience, on an average the pine-barks richest in tannin. In woods in level districts the proportion of tannin is greatest in localities exposed to the light, whilst darkness seems to have an unfavourable effect. Here, also, we must refer to the observation that leaves exceptionally exposed to the light are relatively rich in tannin.

We may here add that in the very frequent cases where a leaf is shadowed by another in very close proximity, or where a portion of a leaf has been folded over by some insect, the portion thus shaded retains a pale green colour, while adjacent leaves, or other portions of the same leaf, assume their yellow, red, or brown autumnal tints. If, as seems highly probable, these tints are due to transformation-products of tannin, we may not unnaturally conclude that they will be absent where tannin has not been generated.

VII. ON THE PROBLEMATICAL ORGANISMS OF ANCIENT SEAS.

IT is well known that Dr. Nathorst put forward the view that many formations, hitherto taken to be fossil plants, are merely the hardened traces left by animals creeping on the mud. M. de Saporta, in a memoir published in the "Bulletin de la Société Geologique de France," replies to this hypothesis, and defends the real existence of the fossil Algæ.

It need scarcely be said that M. de Saporta by no means denies the occurrence of fossilised foot-prints and other traces of animals; but such are excluded in a great number of cases where we have really to do with fossil plants.

In the first place, it is not possible that foot-prints which first were hollow could then be moulded in relief, and impress themselves upon the lower surface of a stratum subsequently deposited over them, so that when separated they could present both surfaces of one and the same object.

Secondly, mere tracks can display no detached portions situate above or at the side of the body to which they belong.

Thirdly, it is not possible that the tracks of animals—walking, leaping, or trailing parts of their bodies after them—could display the fine delicate, sharply-marked and manifold ramifications and meshes which a series of these plants offer.

Lastly, fossils whose branching parts cross, intersect, and mutually cover each other must be true organisms, and not foot-marks, which if they meet may cross each other, but cannot be deposited over each other.

On these grounds M. de Saporta shows that the fossil Algæ called in question by Nathorst and his followers are true vegetable remains, which may be accurately described and classified. The author endeavours also to demonstrate the real existence of the "problematical" organisms which have but a remote resemblance to Algæ. He shows, by an extensive series of instances, that petrifactions in half-relief are no uncommon phenomena in which only one side of vegetable parts—generally the lower—is impressed and remains preserved. But if ancient land- or water-plants exist which are fossilised in half-relief, the main objection to the vegetable nature of the contested structures falls to the ground, and it must be admitted that the half-reliefs may be plants. That such is really the case M. de Saporta shows from the materials which he has collected. He again adduces the interlaced super-imposition of the impressions as a proof of the vegetable nature of the fossils. The foldings and intertwinings of the fossils and other spacial relations are opposed to every possibility of our having before us foot-prints.

A minute and exhaustive study of the foot-prints of animals is certainly of great interest, but M. de Saporta cautions us here against exaggerations.

ANALYSES OF BOOKS.

Modern Science and Modern Thought. By S. Laing, M.P. London: Chapman and Hall.

"The object of this book," as the author tells us, "is to give a clear and concise view of the principal results of Modern Science and of the revolution which they have effected in Modern Thought." The author disclaims all pretensions to bring forward either new facts or new generalisations, but puts before his readers the orthodoxies of Science as laid down by Lyell, Lubbock, Huxley, and Proctor. The successive chapters of the first part of the work discuss space, time, matter, life, the antiquity of man, and man's place in nature. As a whole, the picture given of the universe and of its development is clear, and on a level with the present state of human knowledge. Mr. Laing, however, seems to retain faith in the Bathybius as "a sort of living slime." In the matter of spontaneous generation he accepts a verdict of "not proven." He writes:—"To enable us to talk of the Darwinian 'law' and not of the Darwinian 'theory' we require two demonstrations:—

"1. That living matter really can originate from inorganic matter.

"2. That new species really can be formed from previously existing species."

Now it certainly is no part of Darwin's teachings that life originated spontaneously from inorganic matter; and a demonstration that such was the case, however welcome it might be as confirming the law of Continuity, is not necessary to the establishment of the law of Evolution.

In raising the question of species, the author scarcely brings into sufficient prominence the consideration that the permanence of varieties and races within the historical epoch undermines the evidence supposed to be drawn from mummies, paintings, &c., as to the permanence of species. If the cat and the crocodile were created just as we find them, because their mummies present no essential differences from living specimens, then, by a parity of reasoning, the greyhound and the turnspit, or the semitic man, the Egyptian, and the Negro, are primordial beings, not modifications.

It seems to us that the author, in speaking of human development, places the human infant in too sharp a contrast with the young of other animals. He forgets that the baby mias, according to Mr. Wallace, is for some months almost as helpless as the human infant.

We are unable to agree with Mr. Laing when he says: "When we come to analyse the sum of faculties of the adult man we find that they are derived to a surprisingly small extent from heredity as compared with education." If we take a negro or Fuegian child and give it a European education, it may for a few years seem equal to the young Briton, German, or Frenchman; but about the age of puberty it falls hopelessly into the rear,—nature gaining and keeping the upper-hand over nurture.

In the second part of his work the author passes on to consider the influence of modern science on religious, moral, and social questions. From the very headings of the chapters—"Modern Thought, Miracles, Christianity without Miracles, Practical Life"—it will appear that there is much which lies altogether outside of our cognizance. There is much, also, even in matters coming within our purview, from which we must record our decided dissent. We find the "Gospel of Modern Thought" presented as summarised in certain passages from Lord Tennyson's "In Memoriam," which are here said to "describe the real attitude of most of the thinking and earnest minds of the present generation." The author, in making mention of Carlyle, Renan, and George Eliot, remarks that the whole nature of the first of these writers was "antipathetic to Science." He quotes Froude to the effect that he (Carlyle) liked ill men like Humboldt, Laplace, and the author of the 'Vestiges.' He refused Darwin's transmutation of species as unproved; he fought against it, though I could see that he dreaded that it might turn out to be true." What is said concerning Renan and George Eliot need not concern us.

The Spencerian philosophy is declared to be the highest form of Agnosticism,—"a very different thing from Atheism."

"Positivism" is very fairly judged. Mr. Laing reminds us that as we widen the sphere of patriotism or philanthropy we find them evaporate in a mist of high-sounding phrases. "The 'friend of man' is very apt to be the friend of no one man in particular, and to make universal philanthropy an excuse for neglecting individual charity." Comte's religion, "Catholicism without Christianity," as it has been not unhappily called, is said to "savour too much of the Goddess of Liberty and the theophilanthropy of the French Revolution, when the disciples of Rousseau cut off heads in the name of universal benevolence."

The author's estimate of Spiritualism as "another wide-spread modern delusion" is scarcely in harmony with the facts of the case. He writes:—"In vain medium after medium is detected, and the machinery by which ghosts are manufactured exposed in police-courts; in vain the manifestations of the so-called spirits are repeated by professional conjurers like Maskelyne and Cooke, who disclaim any assistance from the unseen world." Now here is precisely the difficulty. Maskelyne and Cooke have never, as far as we are aware, succeeded in producing under fair test conditions even the simpler forms of "psychography," They have never—though the attention of one of them was especially called to the case—fixed on the wrist of a man an iron ring, like that of Mr. Husk, too narrow to be passed over the hand. The author's remarks on dreams, somnambulism, and mesmerism, however, are worth attention.

Recurring to Carlyle, Mr. Laing makes some remarks of the highest value. He writes :—"The spread of education (he might have added 'the quality of education') has given an extension to the influence of words which threatens to become excessive. People read until they have no time to think, and find it easier to borrow the thoughts of others. And a large and ever-increasing portion of the community have learnt, in Yankee phrase, to 'orate' and use the new-found faculty incessantly and remorselessly. I refer . . . to the undue influence which oratory tends to acquire in all constitutional countries. A great orator is inevitably a great power in the state, but it does not necessarily follow that he is a great statesman."

In the next chapter, on Miracles, we find very sound remarks on their demonstration. He lays down as to the evidence required to prove a miracle—"Clearly it must be evidence of the most cogent and unimpeachable character, far more conclusive than would be sufficient to establish an ordinary occurrence. . . . It may be going too far to say with Hume that no amount of evidence can prove a miracle; . . . but it is not going too far to say that the evidence to establish such a violation (of the laws of Nature) must be altogether overwhelming and open to no other possible construction."

Passing over the discussion on miracles and on Christianity without miracles as not within our competence, we find certain remarks on education, against which a protest is needful; needful because they seem to be a defence of the classicalism, and consequent verbalism, against which our author has just protested. He admits that "the amount of positive knowledge, useful in after life, acquired at our English public schools, is really very little beyond the three R's. A boy who could teach himself French or German in five months, spends five years over Latin and Greek, and in nine cases out of ten forgets them as soon as he leaves school. Almost everything we know that is worth knowing we teach ourselves in after life. But the discipline of school is invaluable in teaching the lesson of self-control. . . . . The memory also is exercised, and the faculty of fixing the mind on work is developed by useless almost as well as by useful studies." But the exercise of the memory is no gain, but a loss, if it comes instead of the due cultivation of the power of observation and of the art of drawing right conclusions from what we observe. That which is agreeable to a boy is generally that for which he has special aptitudes, and if these are suppressed by dint of "canings from the master or thrashings from other boys," a Lyell, a Darwin, or a Faraday may be lost to the world.

The Young Collector. British Butterflies, Moths, and Beetles. By W. F. Kirby. London: W. Swan Sonnenschein and Co.

Mr. Kirby is a most diligent author. In the little book before us he addresses himself to a rudimentary class whose future development we can rarely foresee. The "young collector" may become by degrees an observer of the structure, the development, and the habits of insects, and may thus make valuable contributions to the science of animal life; or he may remain a collector, confining his attention to "British only," giving alarming sums for specimens reputed to have been captured in the United Kingdom (though all the while imported from abroad), and often arranging his specimens not according to their structural relations, but in fantastic patterns; or worst of all, after collecting and spoiling a number of insects, he may renounce the pursuit and take up some other hobby.

The incipient observer we respect, and wish to see him becoming more numerous. In the mere collector, except he has the good fortune to find his way to some district insufficiently explored, we feel no interest at all. The third class we regard as simply a nuisance, since they waste—and, as far as in them lies, help to extirpate—species which have not yet been sufficiently studied. We can therefore only rejoice if he ceases molesting insects, and turns his attention to "philately."

In this work Mr. Kirby first gives a general account of insects, and explains their classification into orders, of each of which some characteristic individuals are described and figured.

Next follows an account of the great order of Coleoptera, with especial reference to British species. The remaining section of the work treats of British butterflies and moths. The descriptions of the families, genera, and species are, from the size of the book, necessarily brief, and are written from a popular point of view. By an unfortunate oversight five species have been figured each twice, namely, *Zygæna trifolii*, *Triphæna orbona*, *Smerinthus ocellatus*, *Vanessa urticæ*, and *Dytiscus marginalis*.

The book is very suitable to be put into the hands of boys who may have opportunities for collecting insects.

The Microtomist's Vade-Mecum. A Handbook of the Methods of Microscopic Anatomy. By ARTHUR BOLLES LEE. London: J. and A. Churchill. 1885.

THE author has brought together into a compact volume a vast collection of formulæ of the preparations used in treating tissues for examination under the microscope; in fact it is the nearest approach to a histological pharmacopœia that has yet appeared. The need of such a compilation is great, as much periodical literature would have to be gone through to find the processes given in the present handy volume.

The methods used in modern microscopical research—such as staining, imbedding, section-cutting, &c.—are given much in detail, with a very full account of all the materials and reagents employed; and in Part II. will be found, in the sixteen chapters which it contains, modes of applying the materials and processes described to various tissues.

The only fault of the work would seem to be that the existence of a vegetable kingdom is entirely ignored. A large number of microscopists study vegetable tissues; and some accounts of reagents, &c., useful in such researches would be welcome. Let it be hoped that this much-needed matter may be added to the next edition.

A Course of Practical Instruction in Botany. By F. O. BOWER, M.A., F.L.S., and SYDNEY H. VINES, M.A., D.Sc., with a Preface by W. T. THISELTON DYER, M.A., F.R.S., F.L.S., &c. Part I., Phanerogamæ—Pteridophyta. London: Macmillan and Co. 1885.

THIS little book gives an account of the course of botanical instruction in use in the Normal School of Science at South Kensington. The first seventeen pages give an account of the methods of making preparations, preserving material for future study, and the various micro-chemical reagents used. Considering how little has up to the present time been published respecting the treatment of vegetable tissues, this portion of the work might have profitably been enlarged.

The structure and properties of the cell are well and clearly explained, and the mode of studying the same under the microscope is given in a very detailed manner.

The practical directions for the study of types are well arranged, and the plants selected for examination are in nearly all instances easily procurable,—a matter of great moment to a town student. The learner is not only told what to do with his plants, but also what to look for when the necessary preparations have been made. Doubtless some of our makers of microscopical objects will soon bring out a series of slides in illustration, after the admirable manner of the late C. V. Smith, of Carmarthen; but students who wish really to learn had better buy or procure somehow only the plants and materials, doing everything else with their own hands.

The present volume concludes with the ferns and their allies, leaving the remaining Cryptogamia for the second part.

The book is free from the pest of a collection of examination questions. Let us hope that the second part may also omit these impediments to students.

*On the Apparent Enlargement of the Constellations, the Sun, and the Moon near the Horizon.** By M. PAUL STROOBART. Bruxelles: F. Hayez.

THIS illusion is the more remarkable because the Moon, when at the horizon, is more distant from us by a radius of the Earth than when in the zenith, and consequently it should appear in the former case smaller by 0·5′.

The author discusses the four principal hypotheses which have been proposed to explain this appearance.

The first of these supposes that the luminary is magnified by atmospheric refraction.

The second, proposed by Alhazen in his "Optics," as far back as the beginning of the 11th century, attributes the apparent en largement of the stars to the flattened form of the celestial vault, the base of which, according to the Arab *savant*, is more remote from us than the summit by an entire radius of the Earth. Hence we imagine the stars more distant from us when they are near the horizon than at the zenith. We know by experience that the more remote an object the smaller it appears. If, then, in imagination we place the Moon on a plane more distant from us when on the horizon than when in the zenith, we ascribe to her mentally a real magnitude more considerable in the first case than in the second.

The third hypothesis agrees essentially with the second. When the stars are rising or setting we see a great number of objects between them and us, which gives us a greater idea of their distance, and consequently they appear greater.

According to the fourth hypothesis, when the Sun and the

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* Sur l'Agrandissement apparent du Constellations, du Soleil et de la Lune a l'Horizon.

Moon are near the horizon they appear less luminous than when they are elevated, which makes them seem more distant and consequently larger. Certain authors refer also to the influence of the lustre of the stars upon the diameter of the pupil of the eye, the contraction of which is said to produce a diminution in their apparent magnitude.

The author rejects the first three hypotheses, but considers that the fourth may contain a portion of truth, since the disc of the Moon and especially that of the Sun appear to have more considerable dimensions at the horizon in foggy weather than when the air is pure. He considers that the apparent enlargement of the Moon is due to two distinct causes, the first, essentially subjective, being that any object placed at the zenith appears only 0·8 of what it does at the horizon; and the second is that the Moon, when it has risen a few degrees, becomes so brilliant as to produce a contraction of the pupil which reduces its dimension to 0·7 of what it was when near the horizon. For the constellations the first cause only comes into play. For the Sun the second cause is felt only when the air is very foggy. Hence the apparent magnitude of the Sun at the horizon is more variable than that of the Moon.

Charles Darwin, and what led to and sustains his Theory. An Address by C. C. CATTELL. Birmingham: Aston.

IN the very outset of this pamphlet we meet with the following sentence:—"Like Sir Charles Lyell, he (Darwin) was free to investigate and teach without anxiety as to his daily bread, or the fear of man to check his speculations. Owing to the pecuniary success of his illustrious father he was a man of leisure, which the late T. H. Buckle considered as one of the essentials of progress and civilisation." Now we are entirely at one with Buckle and with Mr. Cattell, if they mean to say that the existence of a leisurely class is necessary for the highest developments of scientific investigation. Especially is this the case in biology and psychology, where the most splendid results admit of no immediate industrial or commercial applications, and are consequently unremunerative to the discoverer. One of the saddest phenomena of the present age is that the leisure of professional men, and of brain-workers in general, is more and more encroached upon. In this fact we see that modern "progress" is not unlike a swine swimming down a river:—

"The pig swam well, but every stroke
Was cutting his own throat."

But, if we do not mistake, the "advanced thinkers" to whom Mr. Cattell belongs—at least if we may judge from the titles of his works advertised on the fly-leaf—are, as a body, anxious for the abolition of men of leisure. If, therefore, Mr. Cattell shows such views he is scarcely consistent in pointing out the existence of such men as essential to progress.

A brief, plain summary of the evidences of Evolution would be exceedingly useful; but the little work before us does not perform this important task as satisfactorily as we could wish. Even on the question whether man is descended from a lower animal form, or has been specially created as we now find him, some of the most important evidence has been omitted. We might here particularise certain Simian features in the skeleton and the arrangement of the muscles which are very frequent in the lower human races, but which are excessively rare among what is called the Aryan type. Thus the perforation of the humerus, which is normal in the gorilla and the chimpanzee, occurs in about 50 per cent of the ancient human skeletons found in Michigan. (See Mr. H. Gillman, "Certain Characteristics belonging to Ancient Man in Michigan," in the Report of the Smithsonian Institution for 1875.) Still more conclusive are the researches of Dr. Clevenger ("Journal of Science," 1884, p. 134), which show that man is not as yet perfectly adapted to an upright bipedal attitude, and that certain points in his structure—*e.g.*, the arrangement of the valves in the veins—become intelligible only if we suppose them originally belonging to a quadruped. Little less important is a paper by Dr. F. J. Shepherd, on the significance of human anomalies.

Association for the Oral Instruction of the Deaf and Dumb. Report, 1884.

THIS Report testifies to the satisfactory working of the Association's School in Fitzroy Square. The oral system seems to do more towards mitigating the effects of congenital deaf-mutism than any other method which has been tried. Naturally, however, we look to prevention rather than cure. If the Berlin statistics are to be believed consanguineous marriages are the great cause of deaf-mutism: at least persons so afflicted are found, in the different religious bodies in Prussia, exactly in proportion to the extent in which they countenance marriages between blood-relations. Deaf-mutism is most common among the Jews, who rather encourage the intermarriage of cousins, perhaps with a view of keeping property together; next among Protestants, who in Germany are guilty of the same laxity as we in England; whilst the affliction is very rare among Catholics, who do not sanction the intermarriage of cousins at all.

Ocean and Air Currents. By T. D. SMELLIE. Glasgow: J. Smith and Sons. Edinburgh: W. Blackwood and Sons. London: E. and F. N. Spon.

THE author commences his researches with the following simple experiment:—"If you take a flat-bottomed circular vessel, formed to revolve horizontally, partially fill it with water, and make it revolve gently, you will find the vessel at first slip from under the water, so as to give the water relatively a backward motion. A similar result will follow if you try different speeds within the limits of the water being free to take its own motion—the greater the speed the greater the backward motion. After a few revolutions the water will begin to acquire some of the forward motion of the vessel; this will decrease the backward motion; and if continued long enough to allow the water to acquire as much of the vessel's motion as it will acquire, it will take almost, but not quite, the same motion, for the water towards the surface will still lag behind the vessel."

This illustrates on a small scale what actually takes place on our globe. The earth turns eastward, and the water of the seas, lagging behind, forms what appears as a current westwards. This current is of course most marked where the rotation of the earth is most rapid, that is, in the equatorial regions. If these regions were open sea all round the globe, we should have simply one uniform westward current; but as the way is barred by the continents of America and Africa, and is much broken by the Eastern Islands which lie in the track of the current, no such continuous stream is possible. In the Atlantic, when this great current approaches the coast of America, it is deflected in two branches; the smaller goes southwards, whilst the larger, owing to the trend of the coast, turns northwards and forms, among other currents, the Gulf Stream. A part of this goes up into the Polar Sea, and another part southwards towards the coast of Africa to feed the central westward current. In the Pacific and Indian Oceans we have corresponding phenomena.

The same "lagging behind" must produce the chief aërial currents—the trade-winds.

The author's theory is not merely the simplest and most intelligible explanation of oceanic and atmospheric currents, but seems best to account for the phenomena as observed. We strongly recommend this pamphlet to all who are interested in meteorology and physiography.

Where to Find Ferns: with a Special Chapter on the Ferns round London. By F. G. Heath. London: Society for Promoting Christian Knowledge.

This little volume is intended as a companion to the author's beautiful "Fern Portfolio" which we had the pleasure of noticing some time ago. Its object is to give in the briefest possible compass indications of the habitats and the distribution of our British ferns. The author recommends "fern hunting" as a delightful pastime which gives zest to any country walk. He complains, with perfect reason, that life in the present age is far too sedentary. He might here have noticed the educational value of any pursuit which compels men and women to be observers, to gain as much as possible of their knowledge direct from Nature, and not through the medium of words.

Under the head "Definitions of Terms" we find an illustrated explanation of the technical language of botany, as far as it is needful for the lovers of ferns.

Then follows a pleasant chapter on "Fern Habitats," which calls up to our mind delightful memories of rambles taken long, long ago. The author seems scarcely to believe in the extirpation of lovely species in many of their former haunts. We must remind him, however, that the collectors sent out by London dealers are enterprising and persistent, and do not by any means confine themselves to known localities. Not a few, moreover, of private collectors, whether for the herbarium or the fernery, are shamefully greedy, and if desirous to secure plenty of specimens for themselves, seem scarcely less eager that none shall be left for others.

The chapter on the cultivation of ferns is short, but—indeed like the whole of the book—shows the author's thorough practical acquaintance with his subject.

Under the head "Ferns round London" we find an alphabetical list of the localities where certain species may be found in the home-counties. We are glad that the haunts of each species are not laid down too minutely. Thus no encouragement is given to the lazy plunderer who would like to walk to the exact spot and strip it of its rarities.

Lovers of ferns, and naturalists generally, will, we are sure, feel grateful both to the author of this little book and to the Society by which it is published.

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

MATTER AND MIND AN AUTOPSY.

"Und Gott ist heut', 'wer gestern Mensch nur war." *
SCHILLER'S *Don Carlos.*

In the July number of this Journal, the sequel to several former ones with the same earth-shaking motive, is a letter of mine, "Immanence not Transcendance,"† &c., in which, as the synthesis of exact Physical and Medical *data*, I labour to give the death-blow to all falsely-called "Spiritualism," with which it is clear all the Religions of the World stand or fall. I then and there, as in other contributions to Hylo-Ideal Monism, aim at proving that our bodily *sensorium* is virtual creator of all things visible and cogitable. So that when we seem to look "out" into an "external" universe we really look "inward" on the subjective purview of a phenomenal world—Cosmos or chaos as it may be—represented by inner states of our own personal consciousness. No sentient eye, I contend, can ever possibly have beheld an object not the content of solipsismal vision. And no mind can ever think a thought not an act of its own cerebral organism. So that the venerable Cartesian, or other cosmical sophism, "The Universe is a thought of God," must, in our *Neo-hermeneusis*, stand "The Universe is a thought of Man, ultimately of the Self." This change of front is clearly tantamount to the negation of the *Paranomasia*, or cart before the horse provisional assumption, of a separate immaterial Motor, or Vital, Principle to energise brute matter or living body —a theory quite irrational and unthinkable—as the interaction of an incompatible Entity and Pseudo- or Non-Entity, a theory, for near two hundred years past, superseded by the scientific one of Energy as the *function* merely of self-active and dædal Matter or Body *per se*. Immaterial Dualism, or Animism, is indeed identical with Ghostism, "Sacred or Profane," which Physics and Physiology have long since disposed of. Medicine —however the Society for Psychical Research, and eloquent rhetorical anachronists like Mr. A. Lang, in his exhaustive article on *Apparitions* in the "Encyclopedia Britannica," may cavil at the assertion—has quite succeeded in diagnosing as *morbid* cerebral symptoms, and therefore as bodily *infirmity*, not as assumed—an heir-loom of Agriology—in Jewish, Christian, and other Religions, as a spiritual influx or afflatus from a supernal source,—all such alleged Transcendentalism. Even "Nature," divinised by the later Platonists and other Mystics and Pantheists, as now by the vulgar realism of Scientism, is but a mental image of the Ego, a bodiless creation of a *healthy* Brain, as the phantoms of Hamlet, Macbeth, Richard III. are of an *unhealthy* one. No *crux* lurks in these propositions other than the *inertia*, the *damnosa hereditas* of prejudice, superstition, and traditional custom, or second Nature, which, shrinking from the complete *volte face* necessitated by mental innovations, makes such ever a painful crisis in the history of society. Supreme Order, under these conditions, is envisaged as supreme Disorder. Contrary to popular opinion, Mental and Physical Science are quite at one on this *rationale*,—formally since Hume, but informally throughout the whole past ages of Philosophy. Both Bacon and Locke adumbrate the thesis, the latter distinctly stating that the *adit* from human to Divine is an impossible *transit*. Newton, however, *felix cognoscere causas*, was the fortunate formalist who—by his hylo-ideal discovery of Attraction—first placed the Automatism of Matter, and its corollary the nullity of "Spirit" as an inexpugnable verity, on a level with the *Agora*—a heritage of the meanest mind. The *average* general intellect ought, since 1687, to see that since Matter does its own work no other substance is necessary, and that anemistic Dualism, even if thinkable,—*which it is not*,—falls quite to the ground. And yet, *O cæca mens mortalium*, Newton himself—like Priestley later—quite ignored the gist of his own induction. Both of these (to say nothing of later chemical, physical, and physiological discoveries, and notably Wöhler's *pace* Mr. Romanes' hazy ambiguity, in his recent "Rede Lecture," and other Opportunists) establish the truth of Materialism, never doubtful in sound Medical Science, and doom "Spiritualism," the very name of which is a misnomer, to the limbo of other exploded pseudo-sciences, like Astrology, which for many generations held potent sway, not only in the schools, but also in the world of events. A strong trace of it is discoverable even in Napoleon. To Wallenstein, and other 17th century heroes, astral superstition was what religion was to Cromwell, and to belated Chinese and Khartoum General Gordon. Kepler lent it the ægis of his great name. And a prediction of Tycho Brahe, founded on the Emperor Rudolph's horoscope, naively confided in by that generous patron of nascent Astronomy, is reported by Sir D. Brewster to have actually been the cause of his death.

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* God really means only Lord (*Khoda*), the Latin *Vir* (as distinguished from *Homo*), the German *Herr* or *Mann* (as distinguished from *Mensch*).

† By misadvertence this letter did not appear last month.

ROBERT LEWINS, M.D.

THE DRAGON PLANT (*ARUM DRACUNCULUS*).

In an old-fashioned garden, which for more than thirty years has afforded me a miscellaneous store of vegetable treasures, still exist some living descendants of plants belonging to a previous horticultural dynasty, when the garden was in the possession of a Lancashire herbalist. Amongst them is the "Dragon Plant," an *Arum* from the South of Europe, originally imported into this country A.D. 1549. With its reputed medicinal and other virtues I had not cared to acquaint myself; but this season I resolved to observe, more carefully than before, its curious property of emitting a fetid odour during the time of its flowering.

Two grand flowers on the same stock came to maturity together. These were visited several times each day as they expanded. For three or four days from the time when the spadix, and the deep purple lining of the spathe, first appeared, the plant emitted no odour whatever. The spadix was vigorous, and the lining of the spathe in full glory, but no effluvium was perceptible, nor did I observe a fly near the plant. On the following morning the fetid smell was quite sufficiently observable at some distance, and a company of flies were buzzing round and settling upon the plant: amongst them were *Musca vomitoria*, *M. Cæsar*, and *M. pluvialis*. During part of the next day the circumstances were the same; but on the third day the odour had entirely ceased, and not a fly was observable near the plant.

This surprised me, for in previous years I had noticed a longer duration of the disgusting smell. There was no return of the odoriferous emission, and as soon as the spathes were a little withered they were cut off and examined. At the very bottom of the interior of the spathe, in one case, there were three large dead flies; in the other, six. They had crept down over the burst anthers, carrying the pollen to the stigmas below, in search of the nidus to which they had been attracted by the odour of carrion.

One or two points are curious:—The *precise* resemblance between the odour of the plant and that of carrion. We are supposed to know the sources of the smell arising from decomposing flesh; but in the *Arum* there was no decomposition going on, but full vigour of life. If noses were as reliable as ears, I could affirm that the two odours were in perfect unison. Had odours of all kinds been tried in the philogeny of Aroidæ until the development of this particularly beastly scent, fortuitously attained, bestowed the boon of survivorship upon the Dragon Plant? But what a roundabout way, and all to secure self-fertilisation. It is, however, hard to believe that so exact a copy of an odour could have been attained fortuitously or by small increments; and to assert that it *must* have been so is to discourage search after other, not less orderly, ways and means in Nature.

Why should the odour begin and end as it did? The period of its emission was shorter than had been observed in some previous years, when the plants may have flowered in showery weather, and the process of fertilisation may have required a longer time for its completion. In 1885 the season of flowering was distinguished by uninterrupted sunshine, and the flies were plentiful. When the ovaries were fertilised the visits of flies were no longer needed, and the plant ceased to emit the peculiar scent so alluring to them.

Other plants in my garden emitting a carrion-like odour are *Veratrum nigrum*, a brown-purple *Lobelia*, *Pothos fœtida*, &c. The two former attract flies. *Pothos* is an American plant, and flowers too early for the help of the flies. All are of a purplish chocolate or livid colour, nor do I know of any really bright-coloured flower having the taint of carrion. To obtain the exact flavour of the Jargonelle pear from coal-tar the process is one of elimination, getting rid of the pungent elements that would utterly disguise the more delicate forms of sapidity. Is it possible that plant odours may be highly compound—the perfume of the Jasmine, for example, being capable of being analysed into component elements far less grateful when taken separately? The elimination of a corrective constituent in the original odour of the Dragon Plant is more imaginable than the spontaneous production of such a very un-plant-like smell. I saw no special scent-glands, but suspect they were present on the surface of the spadix, which was very like that of a piece of beef after having been exposed for some time to the rays of the sun.

HENRY H. HIGGINS.

SEWAGE TREATMENT AT CROSSNESS.

"But what went ye out for to see?"

YOU will doubtless be aware that the Metropolitan Board of Works recently invited the London Section of the Society of Chemical Industry down to Crossness to see the wonderful operation of making manganate of soda, with which the sewage of the Metropolis is some day to be disinfected. Had the Board heard all the remarks of their experienced, practical visitors, on the arrangement of the plant, &c., they would not have felt highly flattered.

It appeared that the invitation did not extend to the experimental sewage-works. A few adventurous spirits, who did manage to get a peep into these jealously guarded regions, saw enough to convince them that if the Board reject the "A B C process" they are still stumbling over the very A B C of sewage treatment, and trying to keep up, at any rate, the appearance of doing something. There are an alum-tank, a lime-tank, and a manganate-tank. The manganate, it appears, is converted into permanganate by a stream of sulphuric acid, which joins it on its way to the sewage. The quantity of acid which will thus have to be used in pure waste (for the resulting sodium sulphate has no value in purifying sewage, and is, if anything, detrimental) will be far from inconsiderable. Possibly, however, the Board will endeavour to economise by setting up a factory for making their own caustic soda and their own sulphuric acid, and may ultimately come at some startling results. It is not every chemical manufacturer who has the pockets of the ratepayers of London to fall back upon.

SODIUM HYDROXIDE.

BESTIARIANISM IN LITERATURE.

It is remarkable how all classes of literature have become tainted with what is called by its advocates "Anti-Vivisectionism." It is insinuated, more or less broadly, in novels of very questionable morality. It figures in the semi-philosophical writings of the "Shrieking Sisterhood." And it is even taught by prelates in expositions of Scripture. Witness the following passage by the Bishop of Derry:—"Indignation is justly expressed at these scenes of vivisection, where experimenters, with superior smile, grope their way down the dim track of animal pain. But here a man suffered, and no end, even of curiosity, was to be obtained."

These few words show plainly either inability or unwillingness to understand the position of the physiological investigator. The notion of his "smiling" through the microscope could only occur to a rhetorician. In sober truth the experimentalist—whether he be working on animals, plants, or inorganic matter—does not wear a "superior smile." His whole mind is devoted to the task of observing faithfully and interpreting correctly the phenomena which present themselves. As to the "dim track of animal pain," in most cases it does not exist at all, since the subject is rendered incapable of feeling by an anæsthetic. Even where pain does occur it nowise serves us a track leading to any results, and we had much rather dispense with it. To take pleasure in animal pain and death we leave to the sportsman.

It is interesting to note the words "no end, even of curiosity." The love of truth was formerly regarded as one of the highest motives by which a man could be actuated. Now it is contemptuously termed "curiosity."

GRADUATE.

SEX.

IN most countries the sexes are balanced by killing she-children, and as there are prejudices against this in England we ought to do our best in other ways. Yet the cause of sex is the most obscure and neglected domain of ignorance and chance!

Captain Burton says that in Para, Brazil, there are five she-children to one he; but he gives no reason. There seems to be a tendency for sex to follow the senior parent. It has been suggested that male sex depends on nutrition; but the rich have no more boys than the poor, and Earl Spencer's observations on cattle, though valuable, are very imperfect. Is not the best field for observation to be found in eggs? Is the sex decided ere the egg is laid? I believe it is, and that poultry fanciers choose short eggs to produce hens. If not, it would be interesting to know whether sex is affected (or effected) by greater warmth about the centre of the nest and by less warmth at the outer part. Could incubators be made to produce cocks or hens, according to warmth? If not, perhaps the inquiry might be limited to the time before laying, and perhaps it might be pushed back to the spermatozoa. Some observant poultry fancier might give us light.

HUGH BROWNE.

July 13, 1885.

THE SHORTCOMINGS OF THE METRIC SYSTEM.

IT is often left out of sight that the metric system, as at present used in many countries and advocated by lovers of Internationalism, contains and involves very much more and other than the principle of decimal divisions.

It is this "more and other" which makes the people of England hesitate at its adoption. It has been pointed out some years ago, in your Journal, that whilst in our English system the names of the different denominations—grain, ounce, pound, stone; line, inch, foot, yard, mile, &c.—are for the most part words of one syllable, easily remembered, and not easily mistaken, in the metric system this is quite different. One only denomination—the gramme—has a monosyllabic name. The rest are for the most part words of three or four syllables, and not a few of them—such as decigramme and dekagramme, decilitre and dekalitre—are apt to be confounded with each other in speaking and writing, especially when abridgments come in.

But there is another element of simplicity in our English system. We express quantities, either of weight or measure, in terms of whole numbers. If we say that any article is 3 inches long, or that it weighs 5 ounces, no idea save that of the inch or the ounce enters the mind. We know, of course, that the inch is the twelfth part of a foot, and that the ounce is the sixteenth part of a pound; but we are not constantly obliged to keep these relations in mind. We should feel it very cumbersome if—instead of saying that something was 3 inches in length or 5 ounces in weight—we had to say that it was three "twelfths of a foot" long, or that it weighed five "sixteenths of a pound." Yet if we accept the metric system in its present form we shall have this or a similar inconvenience whenever we speak of weights or measures.

T. P.

THE "INVENTORIES."

Ex officio you are—or ought to be—omniscient. I ask you, therefore, how it is that the ruling powers of the "Inventions' Exhibition" show themselves so much less liberal than their predecessors of the "Healtheries" last year?

In 1884 the holders of season-tickets were admitted whenever the Exhibition was open to the public at all. Exhibitors or their representatives could go in and out of the Exhibition premises as often as they found it necessary. Last, but not least, complimentary season-tickets were sent to all scientific and technical journals. This season all this is altered. Who is, or expects to be, benefitted by this narrow policy?

FLANEUR.

THE NEW NATURAL-HISTORY MUSEUM.

In consequence of the strictures of your able correspondent, the Rev. H. H. Higgins, I paid a visit to this out-of-the-way palace, and I found his objections more than verified. The skeletons of whales, &c., are placed in a cellar, where the massive square pillars of brick and stone render it quite impossible to get an unbroken view of the large specimens from any one point.

The great ornithological gallery is principally lighted by a range of *south* windows, which in sunny weather are necessarily kept covered with blinds. Hence many parts are very insufficiently lighted,—*e.g.*, the cases occupied by peacocks and their kindred. Many of the smaller birds, such as the humming-birds (not including the splendid Gould collection), are placed on shelves so lofty that neither the specimens themselves nor the labels are distinctly visible. This is a case of want of room (!), of which there are proofs on every hand.

I should submit that in constructing any kind of building—especially one for a public purpose—the architect should be held to consider first and foremost the purpose in view. This, in case of a museum, involves ample room for extension and good light. In examining any and everything, from the most delicate microscopic objects down to matching off the shades of cloth, a *north* light is insisted on by trained observers. South windows, therefore, should have been rigorously avoided save for passages, stairs, &c.

In the mammalian gallery, in a few cases, the stuffed specimens are accompanied by the skeletons of the species. But the great osteological collection occupies a separate gallery in the top storey. Surely in our National Museum, if not each species, yet each genus, should be accompanied not merely by the skeleton of one of its members, but by typical, anatomical, and embryological preparations. For all this, of course, there is in the vaunted new building—"no room." But how many thousands might have been saved, or how much more room obtained for the same money, had the powers that be taken a practical, common-sense view of the matter. The mistake, for the present, is irretrievable. Parliament will not, during the present generation, vote the money for a fresh building in a more suitable locality.

F. Fernseed.

NOTES.

In 1875 Boussingault found the temperature of hailstones $-10{\cdot}3^\circ$, when the temperature of the air was $+26$. A few days later M. Cailletet determined the temperature of a large hailstone as -9°.

According to MM. Bornis and Daniel, who have conducted observations on the Senegal for five years, there is no relation between the indications of ozonoscopic paper and the intensity of yellow and bilious fever.

We learn that in Russia the works of Darwin, Spencer, Agassiz, Huxley, Lewes, Moleschott, Büchner, Vogt, and Reclus are forbidden to be issued from circulating libraries. Before taking up our parable on this subject let us remember that a few years ago a set of the works of Darwin, Spencer, and Huxley was seized by the Canadian Custom-house as "immoral."

A rose tree growing in the New Gardens, Whitby, is said to have had this year flowers and buds to the number of 3000.

S. Eadon, M.D., M.A., Ph.D., writing in "Light" on the od force, says "Od cannot be magnetism, for that force is only inherent in a few substances, and can only be conveyed along certain kinds of bodies." He ought to know that Faraday proved the magnetic condition of all matter, and that magnetism, unlike electricity, cannot be insulated.

The "Lancet" very justly remarks that faith-healing is simply the converse of the "old trick of making a man ill by persistently telling him he is ill until he believes it."

A gigantic Mosasaurien, from the phosphatic chalk of Mesvin-Ciply, near Mons, has been secured for the Belgian Royal Museum. The length of the skull and of that part of the vertebral column preserved is from 9 to 10 metres. The lower jaw measures $1\frac{1}{2}$ metres.

Messrs. Smith and Dorsey have furnished, at the last meeting of the American Society of Civil Engineers, important results on underground temperatures. At New Almaden, in California, at the depth of 180 metres the temperature is 122° F., but at 450 metres the temperature is quite supportable. In the Eureka mine the temperature at 360 metres is no higher than at 30 metres from the surface.

According to "Science pour Tous" hay-fever and *coriza a rosarum odore* can be traced as far back as the 16th century.

Judge Field, of the Supreme Court of the United States, relates in his Memoirs, just published, that in 1862 there occurred a mysterious epidemic the origin and nature of which have never been explained. A mere touch with the end of the finger was sufficient to convey the infection.

The present Exhibition of Inventions is not, it appears, the only one which has proved attractive to rats. These rodents, like bureaucrats, love exhibitions in general.

According to the Hydrographic Office at Washington the highest waves in the North Atlantic reach 15 metres.

In the Botanical Gardens of Dijon is a poplar 40 metres in height, and 14 metres in circumference on a level with the ground. Its age is estimated at 500 years.

A correspondent at Port Elizabeth informs us that the present winter is more severe than any in South Africa within the memory of man. Some persons in the neighbourhood of Port Elizabeth have actually perished from cold.

Dr. Bonaria, of the Lucknow Botanical Gardens, reports the planting of *Eucalyptus globulus* for sanitary purposes as a failure, and wonders that the tree should ever have been thought suited for this purpose.

According to the "Medium and Daybreak" a mesmerist, by means of "passes," turned a yellow tulip white. Such an operator would be invaluable at bleach-works.

In some parts of Africa the Negroes are of opinion that any man who has survived a stroke of lightning is rendered incapable of swimming.

Prof. Enrico di Mombello, in a recent lecture, described Giordano Bruno as one of the pioneers of Evolution, which he characterised as the old Aryan theory of the universe, in opposition to the Semitic conception of mechanical creation from without.

We learn that at the last meeting of the "Hermetic Society" an adjournment until the winter was agreed upon, in order that the leaders of the Society might devote their time to a crusade against physiological experimentation, or "vivisection" as they are pleased to call it. It is well to know our enemies.

M. Charles Richet finds experimentally that normal children, weighing from 6000 to 9000 grms., produce hourly about 4500 calories per kilo. of their weight.

The evening after-glow so conspicuous in the winter of 1883 has again become very intense, and has been observed in various points of Italy, at Paris, and at Honfleur. Its reappearance is considered not in harmony with the Krakatoa hypothesis.

A statue of Nicolas Leblanc is being erected in the Conservatoire des Arts et Métiers, at Paris—eighty years after the great inventor perished of want. The stone given in place of bread is sometimes rather late.

On a recent occasion much wonder was expressed what could have induced the Metropolitan Board of Works to invite the Society of Chemistry down to Crossness, there to see a "fearful squandering of public money." The few visitors who contrived to see the experimental works describe the odour as most unpleasant.

The "American Naturalist" says—"People who are opposed to what is popularly known as 'Vivisection' may be divided into two classes, the reasonable and the unreasonable." With all due respect to the writer, we, at least, never met with a "reasonable" Bestiarian.

The same journal raises the interesting question, Upon what did the early scorpions—*e.g.*, of Gothland—prey?

Anent the dog-nuisance, we are informed that in the suburban village of Crouch End twelve persons went in one day to a chemist there to have bites cauterised.

Dr. Auer v. Welsbach has succeeded in decomposing didymium—not unfortunately into two known elements, but into two new bodies, praseodym and neodym. Thus the number of elements is increased.

From all sides we hear accounts of the swarms of green flies—winged Aphides. Their coincidence with the unusual predominance and prolongation of the polar current (which is still blowing in this last week of July) is attracting notice.

Mr. R. H. Govett ("Transactions of New Zealand Institute") describes the bird-catching tree, *Pisonia Brunoniana*. The seed-vessels secrete a very sticky gum, in which not merely insects, but birds are entangled and perish. Whether the tree utilises the animal matter thus conveyed to it is not stated.

The Observatory of Harvard College has recently become entitled to a bequest of nearly 300,000 dollars, under the will of the late Robert Treat Paine, of Brooklyn.

M. Leloir ("Comptes Rendus") has studied leprosy in Norway. The disease is confined to the coasts and the neighbourhood of the fjords, and it is altogether becoming much less prevalent: if contagious, it is in a very slight degree.

M. Kourbassoff finds that the bacilli of splenic fever are always transmitted from the mother to the fœtus, and that if a female which has been vaccinated is inoculated during pregnancy with a virulent cultivation the fœtus is not protected.

If Canon Liddon accepts the vacant see of Salisbury, Bestiarianism will gain another advocate in the House of Lords.

A new insect pest, worse than the *Phylloxera*, is said to have attacked the vineyards of Roumania.

Omaloplia variabilis is attacking the hops in certain parts of Bohemia.

It is lamentable to find that about a quarter of a million humming-birds are yearly imported into this country for the gratification of a puerile vanity. In 1872 three thousand skins of birds of Paradise were exported from the Aru Islands. When will this wretched trade be stopped?

Mr. Griffitt, on his silk farm near Smyrna, has obtained 174 lbs. of cocoons from a single ounce of silkworms' eggs.

The recent investigations of M. Aug. Charpentier show the mean position of the maximum of visual intensity is in the yellow of the spectrum, not far from the ray D. The maximum of luminosity is near the ray *b*, on the confines of the green and blue. The luminous perception and the perception of forms correspond to two distinct physiological processes.

According to M. S. Wroblewski ("Comptes Rendus") the electric resistance of bodies decreases much more rapidly than their absolute temperature, and reaches zero at a temperature not far from that obtained by evaporating liquid nitrogen *in vacuo*.

The earthquake at Dorignies-Flers-Douai, in the Department Nord, affected merely the superficial chalk-formations, whilst miners at work in the coal-mines beneath neither heard nor felt anything abnormal.

The "Medical Press and Reporter" mentions the death, at Poole, of a man named Blanchard, from the sting of a bee in the neck.

The "British and Colonial Druggist" writes—"Dr. Frankland resigns the Professorship of Chemistry at the Government School of Science and Mines after the present Session. Candidates for the post may address the Secretary if they please, but there is a rumour about the warming-pan having already been put in the vacant place for the benefit of a certain rather juvenile and very dogmatic Ph.D.

The Rev. J. H. Sutton Moxley, Chaplain to the garrison in Barbadoes, and Prof. J. B. Harrison, F.C.S., after a long series of experiments, find themselves unable to confirm the views of Dr. Freire, of Rio Janeiro, that the graves of persons who have died of yellow fever are foci of infection. Their interesting experiments could not have been undertaken in England.

The Hon. William Macleay, of Sydney (a descendant of the author of "Annulosa Javanica"?), has founded and permanently endowed four Fellowships of £400 each, to be attached to the Faculty of Natural Science in the University of Sydney. The candidates must have taken the degree of B.A. in the University in question, must be actively engaged in research, must hold no other considerable appointment, and are to be liable to annual re-appointment, this being considered necessary to prevent abuse of the endowment.

[We should certainly fear that if these Fellowships were tenable for life they might become mere pensions; but we think that one year is too short a period, since many trains of research (especially biological) may occupy two years or more. Hence we fear that the holders of these Fellowships will be disinclined to undertake any very extensive investigation, which, if not re-elected at the end of the year, they might be unable to complete. We think two years the least time within which a man's capacity and industry can be fairly tested.]

We understand that Mr. Alexander Watt has been for many months engaged in writing a comprehensive practical treatise on the Electro-deposition of Metals, including the Electrolytic refining of copper and other metals, and treatment of ores. The work, being now complete, will shortly be in the hands of the public. The publishers will be Messrs. Crosby Lockwood and Co.

M. Straus finds, from statistics collected in the abattoirs of Munich and Augsburg, that the proportion of tuberculous calves does not reach 1 in 100,000. So that the danger of tuberculosis in obtaining vaccine from these animals is practically null.

The Hainosaurus, a fossil marine Saurian recently found near Mons, is supposed when living to have been about 50 feet in length.

According to the "Adelaide Observer" the line between Gordon and Ballarat was on one occasion so densely covered with caterpillars (species unknown) that a train had to go back for nearly a mile to get sufficient impetus to ascend an incline.

Prof. Huxley's retiring pension is to be £1200 yearly. Who are to be his successors it is not yet known.

17 AUG 1885

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A MONTHLY REVIEW OF ASTRONOMY.

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THE

JOURNAL OF SCIENCE.

SEPTEMBER, 1885.

I. THE POPULATION QUESTION.*

TO the patient and conscientious observer of social facts the population question transcends all others. Until it is solved all philanthropic movements, reforms, and the like, are wont to deepen the very evils they were meant to remove. Or at most they end in transferring penalties and burdens from the shoulders of those who have incurred them to their less guilty neighbours. Sanitary reform, education, temperance, in proportion as they become general, merely intensify the "struggle for existence," or, in other words, the internecine war between man and man.

But unfortunately few, in Britain at least, dare or care to ask whether at the bottom of all we deplore there does not lie the grim fact "too many sheep for the pasture"? If the supply of coal, of soda-ash, of chloride of lime, or any other commodity exceeds the demand, both employers and employed are ready to limit production; but when in a perfectly analogous manner the supply of men and women exceeds the demand, neither capitalist nor trades'-unionist sees the necessity of reducing the output, and, as human beings cannot be warehoused pending an upward movement in the market, untold wretchedness follows.

Into the vexed and difficult question in what manner the increase of population is to be kept within reasonable limits

---

* State Measures for the Direct Prevention of Poverty, War, and Pestilence. By A DOCTOR OF MEDICINE. London: E. Truelove.

—whether, as originally proposed by Malthus, by "moral" means, or by physical methods as suggested by his successors—we do not here enter. But we purpose showing the nullity of the objections currently urged against restriction of population, and then calling attention to a practical difficulty which no Malthusian advocate has succeeded in meeting.

A silly plea sometimes met with is that, since Malthus wrote his celebrated work, regions scarcely known—such as the north-west of the Dominion—have proved to be of great importance as food-producing regions! But if water is running into a cistern at the rate of 5000 gallons per hour, and escaping only at the rate of 4500 gallons, it is idle to show that from an error in measurement the contents of the cistern are rather larger than it had been supposed. Such a discovery may delay, but cannot prevent the ultimate result.

The same considerations apply to the saving of food—which is equivalent to an increase of food-producing area—by reforms and improvements in the growing and cooking of food. Such steps may for a time better the condition of mankind; but if population constantly increases it must necessarily overtake the improved food supply.

The wildest of all contentions is that put forward by Mr. Henry George, who seems to think that the world could maintain a practically infinite number of men if its products were only more fairly divided. At all events he asserts that, on account of the indestructibility of matter and of energy, it could support a thousand billions of inhabitants as well as it now does a thousand millions. It is difficult to realise the mental condition of the man who founds on such data such a conclusion. Let us take an easy example:—Here is a plot of ground sufficient, say, for ten or a hundred apple-trees. All indestructibility of matter and energy notwithstanding, we find it vain to grow in it ten million or a hundred million such trees.

The properties appealed to by Mr. George determine the number of successive generations which may flourish on our planet; but upon the number of individuals of which each generation may consist they have no possible bearing. We may rest assured that all attempts to find a permanent solution of the population question by enactments on the tenure of land, schemes for confiscation, and the like, must be ever doomed to failure. That a finite area cannot continue to support a perpetually growing population is an elementary fact against which it is vain to struggle.

A bolder and at the same time more scientific argument was brought forward by the late Charles Darwin. He admitted that the unlimited increase of mankind was the cause of much misery; but he contended that this misery was the price necessarily paid for the improvement of our race, and that were it removed there would set in a reign of degeneracy and retrogression.

To meet this contention we must bring forward an illustration which is certainly not original, but which strikes us as being unanswerable:—Suppose two turnip-fields which have been sown in the usual manner. The owner of the one—he may be Mr. George, believing that a given plot of land will support any number of organisms, or he may be Darwin trusting in the "survival of the fittest"—leaves all the seedlings to grow and find sustenance as best they may. The owner of the second field, following the usual custom, hoes away all plants above the number which experience proves can find sufficient nourishment on a field of such size. We ask now which of the two fields will, at the end of the season, present not merely the finest and largest individual roots, but the best average? Everyone who has had any experience of farming knows that the competition field would, in sporting phrase, be simply "nowhere." Its finest roots would not bear comparison with the average of the field duly thinned out. We must remember, too, that in thinning out young turnips the farmer does not select for survival the most promising plants. He leaves simply those which happen to stand at the right distance from each other in the rows.

But we need not speak of turnips exclusively. In all farming and gardening operations, and in the rearing of cattle, no struggle for existence is tolerated. The grazier calculates how many sheep and oxen per acre his land will carry, so that each individual may find ample nourishment. The forester takes similar precautions with his young plantations, thinning out the saplings more and more as they require additional room. The gardener plants his young fruit-trees at what an outsider thinks wastefully wide distances apart; he takes similar care with all seeds which yield large plants requiring much nourishment, and he even thins out the clusters on his vines and the single fruits on his peach-trees, &c., on the same principle.

It will be noted that, though different methods are used in accordance with secondary differences, the one essential point is the same in all cases—the limitation of numbers in accordance with the space to be filled. Further, not only is the struggle for existence suppressed between the individuals of the crops or the herds which we are rearing, but the watchful husbandman is ever seeking to root out every weed, to extirpate every kind of vermin which seeks to compete. It is not too much, then, to say that wherever he is able Man stamps out all competition, all struggle for existence, save, on the one hand, in wild animals and plants, and, on the other hand, in himself! Can we doubt that the results of limitation of number, in accordance with the means of support, would prove as beneficial among mankind as they are found to do among the lower animals and among plants?

It must not be supposed that we consider the struggle for existence an unmixed evil, or that we would advocate, were it possible, its absclute suppression; but we hold that it has far passed the limits within which it can stimulate to healthy action, and has entered upon its destructive phase. This is to be observed with heat, light,—in short, with all the requisites of organic existence. Up to a certain point they are necessary; beyond that, as it has often been proved, they are deadly. Just so with the struggle for existence. Where that struggle has been sufficiently intensified by the introduction of new weeds or voracious animals, species begin to disappear. Just so with competition among mankind. We see all types of human beings save the capitalist and the "working-man"—taking the word in its conventional sense—tending to disappear. Hence progress in Science and the Arts must come to a stand-still if the class of leisurely professional men and brain-workers generally is rooted out. What would Darwin have effected had he been flung into a competitive life,—chained, *e.g.*, to the merchant's desk, like Prometheus to the Caucasus? Nor, we will venture to say, could he ever have been born with the aptitudes and the powers which he actually possessed if his forefathers had been men of bustle and worry.

Leaving these considerations to be ruminated on by promoters of competition, we proceed to the great practical difficulty which lies in the way of Malthusianism. Unless universally adopted it must be a failure. Let us suppose that some one nation, some one race existing in any country along with other races, or some one class of society, limits the rate of its increase, whilst neighbouring nations, other races, or classes of society go on multiplying at their present rate: what must be the result? Simply this—that the Malthusian nation, race, or class effaces itself, and in any contest, whether waged with the bayonet or the ballot-box, it goes to the wall.

France has been for some time a Malthusian nation: her population has increased indeed, but much less rapidly than that of the neighbouring nations. From this restriction she has certainly reaped very tangible advantages; she has, so to speak, capitalised the funds that would otherwise have been expended on the nurture of an additional number of children. The competition, both for employment and for food, has been much reduced. But along with these benefits come certain drawbacks which French statesmen are beginning to view with alarm. They announce that the people of France form a much smaller fraction of the total population of Europe than was the case a hundred—or even fifty—years ago. They see that if the present state of things continues France will gradually subside into the position of a minor power, and in the event of war must be crushed by sheer superiority of numbers, just as was Denmark when attacked by Prussia and Austria.

But, leaving war out of the question, we see another method in which a Malthusian nation may be severely injured by its non-Malthusian neighbours, *i.e.*, by immigration. For what does a country gain by restricting the excessive increase of its own population if the room thus created is to be filled up by the influx of aliens, generally indifferent, if not actually hostile, to its interests? Even at present, with our rapidly increasing British population, there is a constant stream of immigration from the Continent which goes far to neutralise the benefit which we derive from emigration to the Colonies, and which is a most cruel wrong to the people of these realms. We may well ask, would not this alien influx greatly increase if we as a nation adopted the Malthusian system?

Again, we may see somewhat analogous results where different races co-exist in the same State. This we may observe at home. We have, indeed, in these islands nothing that can be called formal Malthusianism. But of the two main races of which the British people are constituted, the one—that of Teutonic origin—from prudential motives is apt to marry later than the Celtic portion. Hence it is considered by many ethnologists that in Britain the English and Lowland Scottish element is decreasing, whilst the Welsh, Irish, and Highland Scottish element is increasing.

In the United States of America analogous phenomena are observed. The true, typical Yankee, of English stock, observes the dictates of prudence as regards the time of marriage. The American citizen of Irish descent, and in the South the Negro and Negroid part of the population, observe no such caution. Hence it is observed that the former element is becoming less predominant. We hear of districts in the New England States where the blood of the Pilgrim Fathers has substantially died out.

Something similar may be traced in Europe generally, in the different classes of society. In Malthusian France the families of the wealthy are generally smaller than those of the poor. In Britain the fact that what will maintain one person in plenty, or in comfort, will not maintain five or six in a similar style, is perfectly well known and acted upon. But the still more palpable fact that what will enable one person to exist will not do the same for five or six is completely ignored by those who claim for themselves the exclusive title of "the People"—with a capital P. The lawyer, doctor, engineer, or other professional man, defers marriage until he sees his way to the respectable maintenance of a family. The "British workman" too generally rushes into marriage as soon as he is "out of his time." Hence, mainly, springs the "bitter cry" of which we have lately heard so much.

Hence the more intelligent portion of the community—those who possess and are capable of transmitting to their descendants all the instincts of hereditary culture—are becoming relatively less and less numerous and powerful. Still more would this be the case if Malthusian principles were more fully adopted. We fear that "the People" would still refuse to recognise them, and would be encouraged in so doing by their political leaders.

The practical issue then is, By what spells can the recusant nations, races, and classes be convinced? In default of such general conviction we fear that Malthusianism must have a rather injurious bearing upon those who give it their adhesion.

There seems to be still a principial defect in Malthusianism as taught both by its original and its more recent advocates. It seems to ignore the truths which have been brought into prominence by Mr. Galton under the name of Eugenism. Certain States, we are told, in the work before us, permit no one to marry "unless he can show that he has a fair prospect of being able to maintain a family." To this the "Doctor of Medicine" objects, merely on the ground that such laws "prohibit marriages instead of prohibiting large families; and, secondly, because they apply only to the poor, and not to all classes of society alike." But would not the first step towards regulating not merely the quantity, but the quality of population, be to prohibit the marriage of all persons, rich or poor, who are scrofulous, phthisical, syphilitic, or who show any tendency to lunacy? Yet we do not find, in the work before us, any hint of this kind. We flatly deny that any man or woman can have the right to multiply disease and debility. Those persons will scarcely agree with us who are prepared to sacrifice the well-being of the community to that of the individual.

II. RELATIONS BETWEEN SPIRITUALISM AND SCIENCE:

MR. A. R. WALLACE AND R. M. N.

By the AUTHOR OF "SCIENTIFIC MATERIALISM."

> "Any theory, hypothesis, philosophy, sect, creed, or institution that fears investigation openly manifests its own error."
>
> ANDREW JACKSON DAVIS'S *Motto.*

(Concluded from page 464.)

PERSONS of rank and education have witnessed manifestations, and have given evidence of the truth of the facts. Professor Hare in America, and Mr. Crookes in England, applied the most delicate tests, and proved (in what might be called the minor physical manifestations) that there was no possible trick in the presentments they tested. What was the treatment they received? And then, in the face of such gross scandals, to talk of scientific investigations and other scientific, &c., is the merest irony.

As to the moral aspects of Spiritualism, so far as I have been able to trace the facts, they have had the purest and best results. I witnessed the phenomena in America, on its outbreak there. It is foreign to my purpose to enter into a defence of Spiritualism, to show the good it has done, and the benefits and blessings it scattered broadcast. I could state facts and name names where, in consequence of witnessing the manifestations, the characters of men have changed, and the result has been most beneficial. This much I may say:—I have never known a person who became *truly* impressed by the spiritual idea who was not most radically improved in moral and social tone. At the same time it is not to be denied that charlatanry has entered largely into its precincts, and this is its difficulty: the same difficulty experienced by the Early Christians when base persons presented themselves as teachers, and cupidity (for means or rank) became its almost ruling passion. The sale of remedies, real or assumed, by professing spiritual mediums, and individual payment for *séances*, have wrought much of the mischief.

When R. M. N. talks of the harmony of Science and Spiritualism, and that it will "in the first place be necessary to discover the limits of the power of the Spirits, under what conditions it is exerted, and how it may be combatted when and where it may be undesirable," he will pardon me for saying that he has not given expression to much wisdom. Physical combinations and Spiritual manifestations have nothing in common, and cannot be governed by the same class of laws, and therefore they can never harmonise. To his question of physical facts, wrought as it is said by spiritual agency, the only answer that can be given is the well-evidenced facts and the assumption that such results have been achieved by some supermundane agency. The simplest and most stupendous of the manifestations, the subversion or the apparent destruction of Energy, tend to the same and only result, *viz.*, that there are powers in the outer world of the laws of which men know nothing; that the manifestations of those powers are the proofs that the world life is not the only life of man; that beyond the death of the creature, the soul or spiritual energy of man has an existence, a power and a life, verifying Shakspeare's beautiful ideal—

> "I gazed within the jaws of death and saw life teeming."

In conclusion R. M. N. says—"My estimate of the visions of Swedenborg is founded on the fact that whilst he could furnish descriptions of planets known in his time, such as Jupiter or Saturn, he gives no hint of Uranus and Neptune. *Had he done so his visions would have been completely freed from the stain of delusion and imposture.*"

If R. M. N. had happened on a work, "Nature's Divine Revelations," by Andrew Jackson Davis, he would never have penned the sentence italicised by me immediately above, for in that he would find an evidence in favour of Spiritual seership which he pronounces would in his estimation have freed Swedenborg from "the stain of delusion and imposture."

Before the doctrine of Evolution was known in America so as to be familiar, I have heard Mr. Davis, in a state approaching trance, deliver many lectures on subjects setting forth the same theories and principles as those contained in Mr. Darwin's "Origin of Species." In his normal state Mr. Davis was not particularly intellectual; in his trance state a very different estimate would be given of him. The matter *apropos* to R. M. N.'s observation on Swedenborg's delusion was a spiritual communication given through Mr. Davis (March 15 and 16, 1846) which applies to the planet Neptune, and was announced several months before its discovery by Prof. Galle, of Berlin, in September, 1846. Science, of course, could know nothing of Mr. Davis's predictions :—"*The ninth planet* (or cometary body), being composed of particles accumulated by the motion of the great Sun, observed the same plane by the same specific force" ("Nature's Divine Revelations," p. 165). "The eighth planet" (Neptune)* "was next evolved, observing the same principles of formation and the same general law of motion, and was situated in the orbit of the former merely because its composition was *more dense* than the first one evolved.

---

* From perturbations observed in the motions of the planet Uranus, it was supposed that they were occasioned by the presence of a planet beyond it. By the advice of Arago, Le Verrier was induced to investigate the subject of the motions of Uranus. Complete elements of the orbit of the unseen planet were finally deduced, making its longitude 325°, as seen from the Earth in 1847. Adams, in 1845, attacked the same problem which Le Verrier took hold of two years later. In October, 1845, Adams communicated to Professor Airy elements of the planet so near the truth that, if a search had been made with a large telescope in the direction indicated, the planet could hardly have failed to be found. The Astronomer Royal was incredulous, and deferred his search for further explanations from Adams. The extraordinary circumstance is that no account was immediately published on the subject of Mr. Adams's labours. In the summer of 1846 Le Verrier's elements appeared. Observations of the planet as a star were actually made on August 4th, and again on August 12th; but the observations, owing to Mr. Challis's engagements, were not reduced—so the fact that the planet was observed did not appear. In September, 1846, Le Verrier wrote to Dr. Gall, at Berlin, suggesting that he should try to find the planet. On September 23rd, 1846, the planet was discovered. Later investigation showed that Lalande had observed the planet both on the 8th and 10th of May, 1795, but did not verify it as a planet. The planet Neptune presents the appearance of a perfectly round disk, about 3″ in diameter, of a pale blue colour. No marking has been seen on it. A ring was suspected, but observation showed this suspicion to be without foundation. One satellite only has been discovered (*vide* Newcomb's "Popular Astronomy, p. 358 *et infra*). Uranus has (as recognised) two satellites; Herschel supposed he had discovered six, but this has not been confirmed. Prof. Newcomb supposes there is a planet beyond Neptune; discovery has not yet rewarded his search.

. . . As the eighth and ninth planets have not yet been recognised as belonging to our Solar System, there can be no conception of the original magnitude and diameter of the Sun, as including its extended atmosphere" (*Ib.*, p. 165). The density of the eighth planet "is four-fifths that of water." Its "atmosphere is exceedingly rare, containing but little oxygen, being composed chiefly of fluorine and nitrogen." It has, like Uranus, six satellites" (*Ib.*, p. 167; *et vide* note, p. 169).

Mr. Davis also, in his trance state, insisted on the identity of materials throughout the Solar System. He says "that all matter and elements are fundamentally and essentially *the same*, and . . . a *different* law cannot govern any particle or element in the Universe from that inherent law eternally established." This view as to identity of material in the Sun and planets has since been confirmed by spectroscopic discovery. He also announced Faraday's discovery of Dia-Magnetism before it was familiarly known in America (*vide* p. 227, and an interesting note by Mr. Fishbough), and commented on its actions in Cosmic relations. Surely enough has been said to disabuse R. M. N.'s mind that revelations of mediums are not all delusions. The hostility of the Scientific and Theological world has much of the tone of the cry of the Jews. Can any good come from Nazareth? was there ever a prophet from Galilee?

Science in general deals with tangible phenomena, and because the scientist in his manipulations does not find a visible God, therefore the learned and would be all-knowing scientific theorists reject the interposition and idea of a God; hence arise Agnosticism and Materialism. Fortunately these observations have not universal application, for there are men of Science great in achievement and grand in ideas. How men can dive beneath Cosmic realities and yet deny the designer, it is difficult to understand, for the appreciation and confession of belief in the existence of God pledges to no Theology, nor enchains the acceptor in the meshes of Dogma.

In the investigation of phenomena there is always the presence of the unalterable law. If there be law, an institutor of that law must be assumed: this is a logic many are not equal to. In phenomena is found a sequence of effects induced by preceding causes, which sequences of causes predicate design, because from no concatenation of chances could order and uniformity result. It were quite as feasible and in point to deny the existence of mind because it cannot be put in a crucible and brought out a thought, as to deny design in Nature. When we look at a steam-engine and see the mighty results compassed,—the crushing power of the avalanche, or the tap gentle as the sighing of a zephyr,—no one thinks of the mind of the designer and the intelligence by which the almost living machine is produced, but without which none of the results witnessed could have been produced. So is it the theoretical scientist looks on so-called natural phenomena; he looks only to results. The designer of the steam-machine is known, and if enquired for he cannot be ignored, and the effects produced by the machine remain but effects. How small, indeed, when placed in contrast with the operations of Nature! It is indeed a poor logic which sees and profits by effects, and then denies the intelligence by which they were produced. Spiritualism discloses an occult power. What is its predicate, and where shall it stop?

The one result which the manifestations have produced (whatever more they may have done) is their proof of the existence of an occult world, at present beyond the reach of scientific investigation, of which the once denizens of this world are the inhabitants, and who have the power (regulated by certain conditions) of communication with beings of this life. The all (as I understand it) that Spiritualism claims to teach is the deathless life of the soul. Whatever other inferences its professors and believers please to draw from the manifestations are entirely matters for their own reason and faith. Spiritualism can no more harmonise with Science than Science can harmonise with Religion, for each have separate domains and move in separate directions: the one is casual (Science and Theology), the other causal (Morals and Faith).

III. THINGS *VERSUS* WORDS.

By Frank Fernseed.

IN the spring-time of the present year I was wending my way along a field-path in one of the Midland Counties —the exact date and place being quite irrelevant. From a bush there suddenly rose up a "brimstone" butterfly (*Gonopteryx rhamni*), a survival of last season, and skimmed along over the top of a hedge until it was lost to sight. A little further appeared a "small tortoise-shell," old and shabby, but disporting itself after the fashion of its kind. The thought at once came home to me,—how different are the respective flights of these two species, and how readily an experienced entomologist can distinguish them by this attribute alone, even if too remote to note their characteristic forms and colours!

Here, however, the courteous reader will look round, fully prepared to inflict upon me, in spirit at least, the traditional pinch which in my school-boy days was duly awarded to the bringer of old news. Said courteous reader is in one respect right. The fact is not novel. It has been already pointed out in a much more complete and general manner. There are veteran Lepidopterists who can identify by its flight, if not every British species of butterfly and moth, yet at least every group. But not one of these specialists—and here we come to the point—can describe the flight of each form in such language that a non-specialist would be able to identify the insect by the description of its flight. I may even go a step further: the specialist, however complete and accurate his knowledge of the flight of an insect, will not have this knowledge in all its details stored up in his own mind in the form of words.

It must not be for a moment supposed that the peculiar movements of insects, or of any other animals, are the only properties of things which cannot be described accurately in words. We can, by means of language, put on record with precision the words which have been used by other persons, or our own thoughts and emotions; but when we come to things we can give account of them only to a very limited extent. We can state their number, their weight, their dimension, and their forms, in as far as the latter can be reduced to simple geometrical elements, and everyone will understand us; but the shape of any object, if complicated and irregular, its colour, its smell, its taste, we cannot so describe, save by reference to some other object with which our hearers or readers are supposed to be acquainted. Without some such reference our account of the object is extremely vague,—so vague, in fact, as rarely to lead to its identification. I will take a very simple instance. You tell me that some given object, or some part of such object, is *red*, and you may speak truly. But how am I to know which of the hundred shades, commonly known as red, is the precise one which you mean? Is it a brick-red, or a rose-red, or a blood-red, a cherry-red, or a poppy-red? Is it a red which reflects the same colour from whatever side it is viewed with regard to the light, or does it change like the elytra of certain beetles, the abdomen of the fire-wasps, or the throats and breasts of some humming-birds? Without an answer to these questions the inquirer can form no definite idea of the object in question, and without he has a knowledge of the standards of comparison he cannot comprehend the answer.

We may read in chemical text-books that on bringing certain substances in contact, or on heating them to a high temperature, there takes place a change of colour, a precipitate of some given shade, or a flame which, as the case may be, is blue, green, purple, &c. But the student who merely reads these statements, or hears them uttered by a lecturer without actually seeing the results, forms but a very vague imperfect notion of the facts. To this point attention is now being directed. A chemical manual, recently published in America, is illustrated with portions of the actual precipitates produced, cemented upon slips of paper, and the transitory changes of colour produced in certain solutions by contact with various reagents are imitated as well as possible.

Again, the student is now often told that in order to get a clear notion of any novel reaction, he must not merely produce it with materials of known purity, but he must make trials with substances which give a closely approximating result, so that he may note the shades of difference.

All such instructions convey the admission that language, however invaluable, is a very poor, imperfect, medium for retarding and conveying accurate observations.

I turn from colour to form. If I say that some unknown object is of a triangular or of an hexagonal shape, everyone understands me. But suppose I have before me some newly-discovered animal or plant, how can I describe it so that the general public—educated verbally—can form even an approximate idea of its shape? Words, no matter how skilfully used, will be of no manner of service. I must either give an illustration or—if speaking to naturalists—I must say that the new being is like some known group. Thus if I state that it is a Buprestid every entomologist will know its general features, and its especial peculiarities can then be explained by language, which, however, would be quite unintelligible to such as have not first made themselves acquainted with the thing for which each word stands as a symbol.

In like manner I might go on with the texture or the feel of various objects. Here language is much more impotent than it is in case of shapes and colours. Ask an experienced wool-broker to put into language the characteristics by which on handling a sample wool he judges of its properties. He will laugh at the request as involving a sheer impossibility. He will say that in his experience he has observed certain points in the feel of a wool which indicate its practical value. These points have fixed themselves in his memory, but he has never clothed them in words, and does not know how to attempt it. It is sometimes overlooked that we can, and do, distinctly remember and identify sense-impressions without the use of language at all. We now understand why practical men always say "It is of little use reading about a process; to understand it you must see it done, and do it yourself." And this holds good in the laboratory—physical, chemical, or biological—just as fully as in the workshop.

We now come to an absolutely tremendous *à fortiori*. If language, unaided by illustrations, diagrams, models, and specimens, gives us such a misty, inaccurate notion of the colours and forms of objects, how much the more does this hold good of tastes and smells! For expressing tastes we have a very scant vocabulary. We speak of sweet, sour, bitter, saline, savoury. Beyond this range we help ourselves out with reference to substances of known flavour. But these substances may not be known, and when they are known the similarity is never absolute. There are shades of difference which we recognise and remember, but of which we cannot speak. Where, for instance, is the language in which an experienced tea-taster or wine-taster can record or transmit his knowledge?

With odours the case is yet more decided. Beyond such generalities as pleasant or unpleasant, sweet or nasty, we have absolutely no terms at all at our command except comparisons or references. Hence we constantly find in the text-books, when the properties of any object are being described, such remarks as "Its smell somewhat reminds us of" &c. Yet odours, at least on a person who does not deaden his olfactory organ by the use of narcotics, make very well-defined and permanent impressions. I know an instance where the scent of buchu, once experienced, was distinctly and at once identified nearly forty years afterwards. This proves that, as I remarked above, we can remember and identify sense-impressions directly, without the intervention of language. The person who thus recollected the smell of this herb had no name for his sensation, nor do I see that if he had applied some name to it he would have been by that means at all the better enabled to identify it when again met with.

Indeed it will be found, as a general rule, that we remember our observations, or at least our sense-impressions, directly without the intervention of language, and that we only seek to clothe them in words to aid in communicating them to others.

Seeing, therefore, from the few examples I have brought forward, how very impotent is language, *unaided*, to convey precise knowledge, the question arises—Why is such exclusive attention paid to words, both in lower and higher education, to the almost entire neglect of things? Verbal memory is cultivated above all other faculties of the human mind. Much care is taken to train up youth in the correct use of language. But in what school is the art of observation systematically taught? Who heeds or asks whether the observing faculties are strengthened? Quite the contrary; these faculties, if perhaps not intentionally, are not the less weakened and crowded out by dominant verbalism.

It is sometimes said—and said most falsely—that if the mind is, at the outset of its growth, trained in words and abstractions, it will afterwards deal with things all the more successfully. This assumption has been refuted by the direct experience of Prof. Galloway, M.R.I.A., who has put it on record that the junior classes of boys in schools understand and profit by lessons in Chemistry better than do their seniors, whose observant faculties and whose power of learning from things had been relatively weakened by their longer course of grammar-school training.

But the all but exclusive attention paid to words, and the corresponding neglect of things, engrained as it is in modern systems of education, and though it is the very heart and soul of Examinationalism, cannot be pronounced of modern origin. For centuries original research and observation were practically non-existent in Europe. The only task of the man of learning was to study not Nature, but books; to comment on, discuss, and expound the doctrines of "the Ancients," without any attempt to increase or to rectify the existing stock of human knowledge. Legend represents the sage not as observing and experimenting, but as reading.

To such a length was this carried that the spoken or written word came to be held synonymous with reason. In the East, to this day, a book, a scroll, even a scrap of paper, is looked on as well-nigh sacred.

How came everyone to forget that knowledge must have its origin elsewhere than in books, as otherwise no books could ever have been written? Why was the cistern or the bottle, foul often or dirty, preferred to the spring?

To form even a probable conjecture we must look back to the pre-historical ages,—days innocent of fossil gossip. Man, from the earliest date at which he could be called man, would certainly observe. A part of the knowledge thus accumulated would be handed down even without oral tradition. The young would remember and practise the arts which they had seen exercised by their elders. But much would, for want of any permanent record, be forgotten, and die with those who had collected it,

Hence we may easily conceive that when language reached such a stage as to admit of the transmission, and consequent accumulation, of knowledge in the form of inscriptions, our early forefathers were intoxicated with the value of the step thus gained. They insensibly began to pay less attention to things and more to words, which, as we have just seen, are often but very dim, indistinct transcripts of things: this error seems to have grown until it culminated in the "Socratic apostacy" from which we only returned in the days of Bacon and Galileo. Even now, as I have urged, words still receive the lion's share of attention. In England until very lately men ran through the highest attainable curricula without anything but mere verbal training, and if in after life they proved capable of dealing with anything beyond words and abstractions it was simply in spite of their education. It is to be feared that now a verbal education is being forced upon the lower classes the "vice of inobservance," which has hitherto haunted the higher orders, will be in danger of infecting the whole nation.

In taking my walks abroad I have not unfrequently met with men sheer devoid of literary culture,—unable even to read or write,—but yet good observers who can point out unrecorded facts in Natural History, Meteorology, &c. But, so far as I can trace, the disposition to observe is less prominent in the rising generation. Those who have been duly hunted through the "standards" seem more prone to study the "penny dreadfuls" than the Book of Nature.

I am not seeking to undervalue the use and the study of language. It furnishes, at any rate, receptacles in which the rough outlines of our knowledge may be preserved. But it must no longer seek to maintain the exclusive position which it has usurped. It must be made to feel that it is the espalier and not the vine, the purse and not the money, the shell and not the substance.

An American Professor of Botany not long ago contended that the true way to teach that science was to begin with the actual plants, and refer to books merely to co-ordinate the facts which the student has been led to observe for himself. The text-book, as I have endeavoured to show above, will be definitely intelligible to the man who uses it in this manner, and to him only. All who begin with books, or refer to the actual objects merely—if at all—in illustration, will form such vague notions as a man might form of textile fibres if he handled them with gloves on.

Another American writer who has discussed this subject puts forward a very suggestive consideration :—If language has been evolved, as the scientific world now believes, the observation of facts must have long preceded the elaboration of language. If, then, the evolution of the individual mind is to follow the same course as that of the species, grammar should assuredly be not one of the earliest, but of the latest, studies which the young should take up.

IV. ARSENICAL POISONING BY WALL-PAPERS AND OTHER MANUFACTURED ARTICLES.

By Jabez Hogg, M.R.C.S., F.R.M.S., &c.,
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IT has been very generally recognised that some persons are never well in any given place, or particular locality, long together. In such a case it is commonly said this or that place, or locality, does not agree with them, and, after failure of remedies, change of air is tried with marked improvement; but this proves, in the majority of cases, to be only of a temporary nature. The amount of distress inflicted in this way, in a large number of households, is of no light or insignificant character, and the cause long remained concealed from observation. It is only of quite modern date that a clue has been obtained to certain of the "mysterious illnesses" referred to, and which for yeas were vaguely assigned to some inexplicable cause, —an "idiosyncracy," "antipathy," or peculiarity of constitution.

It is now known that many remarkable and insidious forms of disease are entirely due to certain insanitary influences; that the lurking poison which infests our homes by night and by day may at one time, from defective drainage, find its way into the house through the sewer, to be absorbed in the drinking-water, or, by putting on other kinds of disguises, may for a time baffle the most observant and learned expert.

Who would, indeed, have thought that a deadly poison could lurk in a pretty and attractively coloured wall-paper, a newly-painted decorated room, an attractive article of dress, the chintz of the window-curtains, the stockings, the gloves, the playing-cards of the whist party, the candles and lamp-shades, the children's toys, and the "sweeties." Yet in all of these, and many other articles in domestic use, arsenic enough has been found to produce a large amount of disease, and in some cases death.

It is an unquestionable fact that the health of the community is imperilled by the large use of arsenical pigments and other poisons in the manufacture of articles in general use among us. There is no longer room for doubt of the truth of this assertion in the minds of those who have carefully inquired into the subject. Nevertheless public feeling has not been aroused, at least to an extent sufficient to produce any very marked effect in diminution of the evils which the physician and the chemist have from time to time endeavoured to bring prominently into notice.

In the investigation of an obscure or hidden disease the medical man, in any and every case, is given to associate facts and group together symptoms; and should he find that these recur in pretty much the same order, in a number of cases, and if some distinct or special pathological condition is seen to underlie them and constantly reproduce them, then he considers that he is justified in regarding them as an unmistakable indication of cause and effect. By careful observation it has been found that wall-papers coloured by arsenical pigments will produce, and do produce, a series of symptoms of poisoning which are not only significant, but perfectly conclusive of poisoning by their agency.

It is a well-recognised fact that those persons who are "susceptible" to the action of such potent toxic agents as arsenic, and who may be compelled to occupy a bed-room the walls of which are covered by an arsenical paper, will certainly suffer in health therefrom. That this is so receives additional strength from the fact that immediate relief from a series of distressing symptoms is experienced on removal from the room and its surroundings, and which always recur on their returning to the apartment, or even to the house.

It is a fact, then, that sufferers from arsenical wall-paper poisoning invariably experience perfect relief from all their distressing symptoms on trying change of air,—nay more, by changing one room for another. Any permanent change produces a cure. But on their returning to the influences or surroundings which were the original cause of the illness, they just as surely experience the same train of distressing symptoms which in the first place was the cause of the "mysterious illness."

It may readily be surmised, from these few introductory observations, that the question of arsenical poisoning is in many respects an important one for individuals and for households. From the large number of cases of poisoning already made known by the medical profession and by analytical chemists, I gather that the evil is widespread, and the danger arising therefrom can in no way be exaggerated.

The late eminent chemist and toxicologist Dr. Alfred Taylor was the first to put the public on its guard against secret poisoning by arsenic. He appeared as a witness before the Select Committee of the House of Lords in 1857, at the time the "Sale of Poisons Bill" was under dicussion. Dr. Taylor desired to get a clause inserted in this Bill which should regulate the use of arsenic by manufacturers, but it was urged on their part that it would hamper and injure trade. But although he failed to accomplish his object, he succeeded in arousing the attention of the medical profession to the question. Up to this time even medical men were not fully aware of the danger to health. From this moment very many cases of chronic poisoning by wall-papers were discovered and made known,—illnesses of an unaccountable and perplexing nature were at once understood. Curiously enough, among the greatest sufferers from arsenical papers were several well-known medical men, including Dr. Hinds and Dr. Halley. These gentlemen, happening to read Prof. Taylor's evidence, came to the conclusion that their own distressing symptoms were the result of chronic slow-poisoning by arsenic. In a short time their surmises were corroborated by the great change brought about in their symptoms by simply stripping off the bright green papers hanging on the walls of their consulting-rooms. About the same time the wife of a London surgeon died after much suffering from symptoms which Prof. Stenhouse, after analysing the wall-paper of her room, pronounced "highly arsenical." Dr. Lauder Brunton was inclined to think the evils said to arise from arsenical poisoning much exaggerated. Soon after, and from bitter personal expeience (his study having been papered with arsenical paper), he changed his opinion.

In 1879 a Committee of Inquiry was appointed by the Medical Society of London, of which I was Chairman. In the course of a few weeks no less than fifty-four reports of cases reached me of arsenical poisoning by wall-papers, twenty-four of these occurring in the persons or families of the medical men themselves. This, I think, is strong evidence of the difficulties attending the diagnosis or recognition of this form of illness, poisoning, and tends also to show that the better opportunities for observation afforded to a medical man in his own house may lead to the detection of mischief, which in the person of a patient would escape attention, mar his diagnosis, and mislead him as to its proper treatment. This is so because the gastro-intestinal irritation that attends the internal reception of the poison is mostly absent. It has been discovered, too, that different individuals exhibit very different degrees of suceptibility, so that one person will merely complain of chronic sore throat, another suffer from inflamed eyes and excessive nervous prostration, while it more rarely occurs that the virulent nature of the arsenical poison produces so rapid an effect as it did in the case of Mr. E. H. Corbould, the accomplished water-colour painter. This gentleman was summoned to Osborne to execute a particular work for the Queen, and for which only a very short space of time was allotted; he was therefore obliged to take up his abode at an hotel near the palace. In a couple of days he was a sufferer, as he thought, from a severe cold in the head: this he attributed to the damp state of the bed-room, the wall-paper (a green one) being a good deal discoloured. Her Majesty, hearing of his illness, with her usual consideration for the comfort of those about her, gave instructions to an attendant to have him removed and lodged in Victoria Cottage, close to Osborne, and, furthermore, to see that a good fire was lighted in his bed-room early in the evening. These instructions were carefully carried out, and he found a warm room, a cheerful fire, and every comfort on his arrival. The bed was well covered with the best Witney blankets, and a couple of spare ones ready to hand. After partaking of a little hot brandy and water he gladly crept into bed: in a few minutes a chill seized him, and he was glad to pile on another blanket. He still felt cold, and drew the second blanket over his bed; but in vain,—the chilly feeling caused "his teeth to chatter"; sleep was out of the question. He bethought himself of his well-lined Spanish cloak lying on a chair near the bed, and made an effort to reach it: to his horror he could not move his legs; he was paralysed, and could neither move arms nor legs. He made a violent effort to put his legs out of bed: this produced a painful cramp of the bowels, and this was immediately followed by sickness; soon after he lost consciousness, and remembered no more of what occurred. At 8 o'clock the following morning he was aroused from his insensible condition by a loud knocking at his bed-room door; he was scarcely able to say "Come in," or ask for a cup of tea. In a few minutes the servant returned with the tea, and pulled up the blind: he opened his eyes, and, seeing the brilliant green of the paper on the bed-room walls, excitedly exclaimed "I am poisoned." The servant, in great surprise, declared she had given him "nothing but the best tea." He explained, as he drank it, that he alluded to the paper on the wall. He made an attempt to get out of bed, and his legs gave way under him, and he staggered about like a drunken man. As soon as he could he opened his door and got out, and reeled to a window that stood open in the corridor. The fresh cool air of the morning seemed to infuse new life into him; he breathed more freely, and gained power over his limbs; in a few minutes he was able to make his way out of the house. As he walked up the green sward every disagreeable symptom vanished. The Queen was waiting for him, and remarked he was late, and he was obliged to confess that illness was the cause; at the same time he stated that he had been poisoned by the wall-paper of his bed-room. Her Majesty expressed great sympathy, and at once commanded an attendant to have a piece of the paper stripped from the wall of the bed-room and brought to her. This was submitted to chemical analysis, and found "highly arsenical." This interesting case shows the extraordinary susceptibility of some persons to arsenical wall-paper poisoning. At the same time the remarkable activity of the toxic agent may have been gently promôted by the temperature of the room, and its having been occupied for the first time after repairing and painting. The poison doubtless entered the circulation through the lungs in a gaseous form (hydrogen arsenide), thus producing anæsthesia, then followed arrest of the heart's action, and paralysis of the nervous centres. In some cases, coma and death ensue.

In the greater number of cases arsenical poisoning takes place slowly and insidiously; it begins with headache, dry cough, oppressed breathing, giddiness, and sleeplessness; the limbs are painful, feeble, trembling, and benumbed. In other instances it attacks the surface of the body, causes chronic skin disease, or the fingers and arms are covered with painful sores. In an establishment where a hundred young girls were constantly employed making artificial flowers and leaves, the greater number of them suffered from eruptions and painful cracking of the skin of the fingers and flexures of the arms. Twenty-six of them presented other symptoms of chronic poisoning, and one died, after months of great suffering, from ulcerations attacking various parts of the body.

Workmen while engaged in stripping off old wall-papers from rooms, preparatory to re-papering, are frequently obliged to leave their work from attacks of diarrhœa and other stomach derangements. Hundreds of instances of dangerous illnesses have been published, from time to time, which fully confirm what has been stated with regard to the reckless use made of arsenical pigments in various manufactures, and the dangers arising therefrom.*

On the other hand, it has been said that some exaggeration has taken place with regard to the numbers of the sufferers from arsenical poisoning, and that the subject has been hitherto treated too sensationally.

We have been credibly informed, also, that the men employed in the manufacture of arsenic in no way suffer from arsenical symptoms, and that on the whole they enjoy good health. The Inspector of the Cornwall and Devon mineral mines, Mr. R. Hunt, says the miners are a healthy set of men, and those engaged in arsenic mining make no complaint of the unwholesomeness of the work. The miners of Upper and Middle Styria are actually given to chew small pieces of crude arsenic, and believe in it, as men do who smoke and chew tobacco. It is said to relieve hunger, and give increase of strength. It is also supposed to be a protective against the fumes arising from the reducing-furnaces.

On careful enquiry by competent persons the conclusion come to is that there is some exaggeration in these statements. It is, however, quite probable that men do chew minute pieces of crude arsenic with impunity; but then crude arsenic is insoluble, and may pass through the stomach without having been acted upon by its secretions. Many cases have been published that prove the truth of this assertion. But the case is very different when we have to deal with a perfectly soluble salt of arsenic, as the trioxide. Of the many arsenical preparations used in our manufactures the most dangerous, because the most extensively employed, is the trioxide. This is the principal ingredient in Scheele's green, a pigment composed of 1 part of arsenic trioxide and 2 parts of cupric oxide. Schweinfurt, Brunswick, Vienna, or emerald green, aceto-arsenites of copper, are all rather extensively used, mixed and unmixed, with such other materials as zinc oxide, in producing more delicate tints of colour. Another pigment, composed of chromic and ferric arsenate, is much employed, while arsenic acid enters into very many manufactures, aniline dyes in particular. Roseine, for instance, is produced by the arsenic acid process.

In wall-paper printing, as in many other textile fabrics, the arsenical pigment is invariably mixed with zinc and some organic matter. This is done with the object of causing the colouring-matter to adhere to the paper, muslin, or calico, and in consequence its mischievous effects are likely to be augmented, for the fabric on becoming thoroughly dry will be detached by rude handling; the surface cracks, and the pigment is loosened, when considerable quantities of arsenical dust will be set free.

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* For further details of numerous interesting cases of poisoning by arsenical pigments see a paper of mine in "The Sanitary Record" of April 25, 1879, and "Medical Press," 1879; also Mr. Henry Carr's useful work, "Our Domestic Poisons," published by Ridgway and Co., and in which appears a list of numerous other publications on arsenical poisoning

In the case of a wall-paper hung on the walls of a room, every increase of temperature will liberate a quantity of the surface-dust, which settles on the furniture; or the arsenious acid, which is of an extremely volatile nature, may be changed into hydrogen arsenide and diffused by every movement of the air. But I am reminded by an objector that the quantity of dust thrown off under any circumstances is far too small to produce the dangerous and disagreeable effects in the human economy such as I have spoken of. This, at least, is a hasty conclusion to jump to. Professor Taylor found that from each square foot of an arsenical wall-paper he could obtain from fourteen to seventeen grains of arsenic, and that from some flock-papers he actually obtained as much as fifty-nine per cent of arsenic. Other chemists have succeeded in eliminating a quantity of hydrogen arsenide from wall-papers, and have in fact obtained from each cubic inch of gas one grain of arsenic. Dr. Fleck, of Dresden, repeating his experiments, satisfied himself that the element of greatest danger is found in the evolution of this gas by the joint action of heat, moisture, and the organic matter used in printing and hanging the paper. Professor Sir H. Roscoe takes a similar view; and Dr. Hamberg, of Stockholm, who was himself a sufferer from arsenical wall-paper poisoning, having repeated Dr. Fleck's experiments, convinced himself that the respiration of hydrogen arsenide in a comparatively short time will produce symptoms of poisoning. Within the body this gas or dust may produce other poisonous compounds by decomposition of albumin. Professor Selmi discovered that a volatile arsine was formed by contact of arsenious acid and albuminous matters, and that the new compound formed exhibited a toxic action differing from that of arsenious acid; he further expresses his belief that a similar product may be formed from the size used in making the wall-paper and the paste employed in fixing it to the wall, and if so, the moisture of the air would play an after important part in the formation of a poisonous material, *arsine.**

* The enormous volatility of the arsenious tri-chloride necessitates special precautions in its preparation. The gas evolved is driven off at a very low

But whether the greater activity of the arsenical wall-paper poison is due to the crystalline particles separated, thrown off, from the surface of the wall-paper, or liberated by albuminous decomposition or recomposition, as hydrogen arsenide, it is scarcely possible to say. This after all is a question of far less moment to the public than to medical men and chemists. At all events the difficulty is just as great with regard to lead poisoning. It is almost impossible to conceive, much less explain, why a person sleeping in a newly-painted room should find himself unable to move hand or foot on waking. He at once becomes a sufferer from lead paralysis, and no one has yet detected either carbonate or oxide of lead, or other subtile agent, diffused throughout the air of the room. Nevertheless, it must be so.

If, then, as I have shown, arsenical wall-paper poisoning constitutes a serious and pressing danger to health it will surely not be denied that the use of arsenic in our manufactures should be placed under some restrictions. By the intervention of the Foreign Office we are in a position to say what is done in this respect by the Governments of other European nations. As regards Germany, the use of poisonous pigments in wall-papers, and in other fabrics and materials likely to affect health, are absolutely prohibited by law. By an imperial Law issued in 1879, all colours deemed poisonous are fully enumerated. The use of Scheele's green and of all other arsenical and poisonous colours for wall-papers and clothing are therefore prohibited, not only by the laws of Prussia, but by those of nearly every minor State. An exception was subsequently made in the case of papers, &c., intended solely for exportation, so that German manufacturers might not be placed at a disadvantage in competeing with French firms; but the restrictions imposed on the use of arsenic were found so onerous and harassing that the manufacturers themselves found it the more profitable course to discard arsenical colours altogether.

In the kingdom of Saxony legislation has been of a piecemeal character: the use of a green precipitated copper carbonate on cotton yarn having been forbidden in 1840; of a Brazil or Munich red, an arsenical colour in 1856; of Schweinfurt green for fabrics and papers in 1860; and a warning issued to the public against the use of arsenical colours in sleeping or much frequented rooms, and in forms

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temperature, and will pass over before a single drop of condensed liquid enters the receiver. So difficult is it to obtain in solution, that Hufschmidt convinced himself that every trace of the trichloride remains in the receiver, whether it be filled with water or solution of potash.

easily detached. In Saxe-Cobourg and Gotha ducal edicts have been in force since 1839 prohibiting the use of arsenical pigments for all domestic purposes, and a scheduled list of dangerous articles given which must not be introduced into articles of food or drink. The Hessian Criminal Code of 1855 is more stringent, and specifies a number of colours which, though not coming within the category of direct poisons, are of a poisonous nature and injurious to health; it not only regulates their use but prohibits their sale by chemists and others, thus far more nearly corresponding to the "Sale of Poisons Act" of this country.

In Bavaria a law of 1863 enacts that arsenic is not to enter into colours and paints for house decorations, window blinds, wire gauze for meat safes, artificial flowers, &c. In Sweden the question of arsenical colours has been the cause of much discussion at home, and of negotiations with the Governments of other countries. The ordinance of 1876, which regulated the manufacture, storage, and sale of poisons of all kinds, unconditionally prohibited the use of arsenic in wall-papers, cloths, blinds, artificial flowers, and wares of all kinds, as well as in lamp-shades, sealing-wax, wafers, and candles. It was thought carpets were not included, but the Courts ruled these as an accidental omission and they were accordingly included, carpet sewing having in some cases produced arsenical poisoning. By the Act every purchaser of an article possibly arsenical can have it analysed and certified by the Government chemist. It also fixes as the limit of security in wall-papers, namely, that the metallic arsenic deposited in a glass tube of 1½ to 2 millimetres internal diameter from 440 square centimetres of these articles, or from 220 square centimetres of textile fabrics and 21 grains of other articles, by the Babo or Fresenius process, shall not produce a black, brown, or even a partially opaque arsenical mirror.

Denmark and Holland stand next in point of stringency of their regulations on the use of arsenic and other poisons in the arts. In Denmark a law has lately come into force based upon that of Germany, and which prohibits the use of arsenic in wall-papers, carpets, window blinds, artificial flowers, and fabrics of all kinds, and in all descriptions of paints, distemper, or colouring for walls, or decorative purposes. 2. The use of lead in toilet articles, and in enamelling or tinning cooking utensils, or of oxide of lead or zinc in india-rubber for infants' feeding-bottles, toys, &c. For the use of arsenic, antimony, lead, chromium, cadmium, copper, cobalt, mercury, lead, zinc, and of gamboge in toys, or for colouring confectionery, foods, and drinks. Colour-boxes containing any of the above are to be labelled "poisonous colours."

Holland has just passed a law which makes it a crime to sell any article of merchandise of a poisonous character without giving the purchaser full information as to its precise nature. If any article be sold without this notification the vendor is subjected to a fine not exceeding 300 florins, or imprisonment for a term not exceeding six months. Should death follow as a consequence of the sale, the seller is liable to imprisonment for a term not exceeding one year if he were ignorant of its nature, and to various other terms—even for life—if he knew the nature and the probability of such a result.

In France the use of poisonous colours is prohibited in articles of food, but as to others not intended for consumption no prohibition is in force, and the Government contents itself by the issue of a circular cautioning manufacturers of the responsibility they incur in case of poisoning, and their liability in consequence under the penal code.

In Italy the sale of poisons is strictly regulated by law. The sanitary code of the Commune of Venice includes among its poisonous colours the juice of the phytolacca, much used in Portugal for colouring port wine. It forbids also the use of lead or copper in the manufacture of articles not tinned and polished, in utensils for the preperation of articles of food and drink. In pewter-pots and metal tea-pots not more than five per cent of lead or of antimony must enter into their composition.

In Greece and in Roumania poisons are not allowed to be sold by other persons than registered chemists. The use of poisonous colours is prohibited in certain articles scheduled. In Servia the Government medical officers and analysts may at any time enter and inspect all places where poisons are used, manufactured, or sold; and if fatal consequences ensue on a breach of the law, the offender is made amenable to the criminal courts.

In Switzerland the Federal laws bearing on this subject are very variable. In some cantons the laws simply regulate the sale of poisons. Geneva, Berne, St. Gall, and Zürich alone have very explicit legislation on the subject. In the first-named all poisonous colours, inorganic or vegetable, are prohibited in articles of food, in wall-papers, and fabrics of all kinds.

In Berne, arsenic, aniline containing arsenic, and metallic colours generally are forbidden to be used in food, toys, wall-papers, and textile fabrics. Copper utensils are also required to be tinned. In other cases paints for internal decorations, and all articles of domestic use, are included and enumerated. The most complete regulations are those met with in Zurich, where, for the colouring, painting, and ornamentation of articles of food, drink, and clothing, the paper envelopes of food used in confectionery, toys, wall-papers, window blinds, wafers, &c.; the employment of colours containing any compound of arsenic, lead, copper, antimony, zinc, mercury, or bismuth are absolutely prohibited. Imported articles containing any prohibited colours are not allowed to be sold.

In Austro-Hungary there is an Imperial law forbidding the sale of poisons, but it imposes no restriction on their use in trades and manufactures, while in Spain and Portugal there are no laws whatever bearing on the question of poisons. From what we know of the backward state of therapeutics and medicine in these countries this is not surprising.

It is but right to state that harmless pigments of proved utility and value have been prepared to replace arsenical colours in the manufacture of wall-papers in this country, and that every precaution is now taken by the larger firms of wall-paper printers to prevent as far as possible the use of poisonous colours, or those likely to be injurious to health, being introduced into their printing works. They buy only colours guaranteed free from arsenic.

Some months since the Council of the National Health Society appointed a Committee of medical men, chemists, and others to collect information as to the effects on health of poisonous pigments and colours in articles of home decoration, domestic use, and wearing apparel, with a view of obtaining legislative action in this important subject. A Bill has been framed, which, it is hoped, will be early intro-into the New Parliament, and without much further loss of time placed on the Statute Book.

V. ON THE SELF-PURIFICATION OF WATERS AND SOILS.

F. EMICH has carried out a series of experiments on the behaviour of water when allowed to stand exposed to the air, and also when shaken up with air. He has further experimented with sterilised water, and on the behaviour of waters submitted to the action of ozone and hydrogen peroxide. The self-purification of water—in other words, the destruction of its organic and inorganic impurities—may be the consequence either of a purely chemical process (oxidation) or of a biological process. It appears that on exposure to, or agitation with, air the self-purification of water takes place only if it has not been previously sterilised by boiling, and protected afterwards against the entrance of germs. But if a sterilised water has been subsequently exposed to the air, or mixed with ordinary water, it undergoes the same changes as waters which have not been sterilised; its oxidisable power and its proportion of ammonia decrease, whilst nitrous or nitric acid is formed. If, therefore, the development of organisms in the water is rendered impossible, self-purification is also impossible, the latter process being dependent on the former.

Direct oxidation by atmospheric oxygen certainly does not take place. Ozone and hydrogen peroxide may possibly co-operate in the natural purifying process, but they play in any case a subordinate part.

In connection with the conclusions reached in the foregoing paragraph, the disappearance of the free dissolved oxygen in rivers, where impurities are introduced, must not be forgotten. This disappearance is an analytical fact, and if the missing oxygen has not served directly for the oxidation of the impurities, it must have been transferred to them by the action of the microbia.

The kind of living beings which effect the purification of waters, converting more complicated compounds into simpler ones,—in other words, de-organising or mineralising them,—will differ greatly according to circumstances. Such a change of species has actually been observed in one and the same water-couse in the different stages of its pollution.

It must be remarked that, as far back as 1869, M. Müller instituted experiments on the self-purification of contaminated waters, and pronounced it a vital process. He was disregarded, however. Now we must regard the entire question of self-purification as removed from the field of pure chemical research.

Even when industrial refuse of various kinds has been allowed to flow into a river, in addition to organic pollution, it has been again and again demonstrated that self-purification can and does take place. But practically speaking we must beware of supposing that the treatment of foul waters should be left to Nature. Where the supply of polluting matter is continuous in time and space, natural purifying agencies fail.

Dr. J. Soyka has almost simultaneously been engaged with a series of experiments on the power of the soil to absorb poisonous substances from the soil, and to destroy them. Solutions of strychnine sulphate, hydrochlorate and acetate of different strengths, were filtered through a cylindrical stratum of gravelly soil, 32 inches in depth, 155 grain measures of the solution being poured on daily. After the soil had received a quantity of the solution corresponding to its capacity for water, the excess drained away, but perfectly free from strychnine. The size of the granules of the gravel had no perceptible influence.

The addition of strychnine solutions was then repeated until the soil was no longer able to retain strychnine. It was then found that the gravelly soil was able to withdraw from solution 0·5 to 0·6 per cent of its weight of a strychnine salt, and 0·4 per cent of its weight of pure strychnine.

A similar result was obtained with quinine, morphine, atropine, pyridine, piperidine hydrochlorate, cinchonine sulphate and hydrochlorate.

It is much to be regretted that the author did not consider it necessary—or perhaps had not the opportunity—to repeat these experiments with any of the ptomaines, bodies much more likely to occur in soils, and whose elimination is, under certain circumstances, of no small sanitary importance.

The more gradually the poisons are incorporated with the soil, the more of them is retained. The soil, however, decomposes the salts which it withdraws from solution. This decomposition takes place quantitatively. The acid reappears in the filtrate, whilst the alkaloid remains in the soil, and for a time unchanged. Both chemical analysis and physiological experimentation prove that it is not decomposed.

The subsequent destiny of the absorbed alkaloids was determined by experiments carried on for some months. When the soil, saturated with the alkaloid, let the solution pass through unchanged, it was gradually washed out with water. In the filtrate the ammonia and the nitrates were determined, and it was ascertained that, in 167 days, 60 per cent of the nitrogen of strychnine reappears in the filtrate as nitrate, so that in time a complete self-purification of the soil from the poison may be expected.

The first traces of nitrates could be detected in the filtrate at the expiry of eighteen days. If the soil had absorbed quinine a different ultimate product appeared in the filtrate, namely, ammonia. This important difference in the transformation of the alkaloid depends doubtless on the different action of the alkaloids employed upon the nitrifying organisms in the soil.

Peat possesses a greater absorptive power for alkaloids than gravel, but decomposes them much more slowly. If solutions of alkaloids were filtered through charcoal, the filtrate contained large quantities of carbon, even on the third and fourth day after the beginning of the experiment. As the nitrifying organisms had been killed by the ignition of the charcoal, nitrates could not be formed.

These experiments throw little or no definite light on the persistence of non-volatile organic poisons in the animal body after death. We may perhaps, however, venture to assume that as strychnine is decomposed more slowly in peat than in gravel, it will prove not less permanent when existing in the tissues of the animal body.

Other questions may be raised concerning the ultimate result of the disposal of liquid or semi-liquid putrescent matters by irrigation. The experiments described at any rate confirm the conclusion drawn from the soakage of cesspools and grave-yards into wells and streams,—that a given limited quantity of soil cannot absorb and retain an unlimited quantity of organic matter.

An important lesson to be learnt from the researches both of Emich and of Soyka is that the microbia, both of earth and of water, are not necessarily to be regarded as disease-generators. On the contrary, we see that certain kinds of them are converting malignant matter into forms in which it is harmless, or even useful. Hence it is at least possible that, even in the application of disinfectants or "germicides," there is room for discretion.

VI. A GLANCE AT EPPING FOREST.

WE consider it our duty to revisit this rescued territory from time to time with a view of scrutinising its management, and of satisfying ourselves whether it is improving or retrograding. Truthfulness compels us to explain what we mean by improvement or retrogression. The Forest is improving if it becomes, from year to year, a more comfortable refuge for our native flora and fauna. It is retrogressing if it is becoming more monotonous in its features, and if animal and vegetable species once found here are being exterminated or driven away.

Accordingly on the 2nd of July we went to the Forest, in company with a zealous Lepidopterist, and made our approach by way of Chingford. The day was calm and sunny, so that everything wore its most favourable aspect. The first phenomenon which impressed itself upon our senses was utterly loathsome. No person can leave the Chingford Station—whether he ascends the hill to the Forest Hotel, or takes the newly-repaired road to Sewardstone, or, as we did, strikes diagonally over the waste into the Forest—without crossing a most loathsome open sewer. Who is responsible for a nuisance thus thrust into the way of thousands of excursionists we cannot say. Nor do we know why its emanations should be so exceptionally unholy. But there it is, and there it ought not to be.

We crossed the waste land which, though disgorged by the whilome encroachers, has not been, and probably never will be, restored to its natural condition. It has, however, its attractions for "the People." There are swings, merry-go-rounds, shooting galleries, cocoa-nut shies, steam-barrel organs grinding out discords unearthly but not heavenly. Worst of all there are troops of under-fed horses and donkeys, let out by the half or quarter hour to awkward riders, and cudgelled both by their owners and lessees. A truthful "zoophilist"—if such a species exists—would confess that in the outskirts of Epping Forest alone a greater sum of pain is inflicted upon "dumb animals" than in all the physiological laboratories of the world.

But we cannot stop to moralise. On entering the Forest at its lower margin we soon found it very much changed from its aspect only a few years back. Numbers of trees and vast quantities of bushes had evidently disappeared. Here and there trunks lay prostrate, whilst charred and blackened spots showed where the brushwood had been consumed. Besides all this, deep channels had been cut in the clayey soil, conveying away its moisture to that puerility the "Connaught Water," entirely out of keeping with the general character of the scenery. In consequence the ground, which in this portion of the soil had been naturally damp, and in many spots even somewhat swampy, was now dry. A change had in consequence come over its vegetation, which was, as far as we could judge, becoming less varied and luxuriant. The way in which the axe and the bill-hook had been used had also effected a great change. Formerly a prominent feature of this region of the Forest was glades of an irregular shape, 5, 10, or perhaps in some cases 20 yards across, walled in with dense masses of shrubs, such as sloe, whitethorn, and wild roses. These glades, screened from every wind and guarded against the desiccation of the soil, were the favourite haunts of butterflies, moths, bees, and other insects. Now we do not feel free to say that none of these retreats are left, but they are certainly far less numerous than formerly. The mounds of vegetation, which screened them from chilly winds and from drought, have been broken down, and they are rendered comparatively bleak and arid,—a kind of "Conservation" which the insects and the birds evidently do not appreciate. The lower edge of this region was once a favourite haunt of the viper and of the grass-snake; but on the day in question no trace of either of these reptiles was perceptible. Our friend was much struck with the obvious scarcity even of the commoner kinds of butterflies.

One moth, indeed, the green Oak-Tortrix, was but too common. It was dancing among the topmost branches of the trees, and descended in perfect showers if a bough was shaken or struck. The damage, which had evidently been wrought by these little creatures whilst in the condition of larvæ, was amazing, the leafage of the oaks looking quite shrivelled up. For this pest neither the Conservators, nor the "experienced Forester" (their adviser), nor even H.R.H. the Ranger, had found any remedy.

A curious fact is that numbers of these moths were sitting on the smooth trunks and branches of the trees, where their bright green upper wings made them quite conspicuous even at a distance of 6 to 8 yards. This is certainly not a case of "protective colouration." Many species of insects seem to select resting-places agreeing closely in colour with themselves, and thus escape the notice of their enemies; but this Tortrix seemed almost to court observation. Especially a vast number of pairs *in copula* had selected such exposed situations. Can it be that this species is so far secured against extinction by its fearful fecundity that it has not acquired the usual protective instincts?

As we went on and on, one point at least became evident: the Conservators were doing no further mischief. No workmen were to be seen; no more trees were being felled, and no more draining operations were being conducted. But this is small consolation. The question is how the mischief is to be undone? The bushes will, if unmolested, gradually grow up again and shut out the wind; but Nature, we fear, without active assistance, will be powerless to block up the drains and to retain in the Forest the moisture which now goes to feed the "Connaught Water." And we do not see how the "Conservators" can be brought so far to reverse their policy and own themselves in the wrong.

Crossing the Epping Road, and visiting the high grounds in the extreme north-eastern part of the Forest, we found that the old gravel-pits had been filled up and levelled. Now a recent gravel-pit is no very attractive object; but when it has become old, when its bottom is a pool,—the haunt of water-plants and aquatic insects and molluscs,—and when its sides are covered with straggling vegetation, it becomes precious to the naturalist. We greatly fear that, as far at least as this locality is concerned, entire species have been exterminated by the levelling operations, the filling up of the gravel-pits in this part of the Forest. We saw, for instance, not a single tiger-beetle. And if we remember that the slopes of these pits were the chief spots where the larvæ of this insect burrowed, we may well suppose that such a burial must prove fatal. Similar will have been the fate of various fossorial Hymenoptera.

In the same section of the Forest, but at a much lower level and nearer the Epping Road, was formerly a rushy spot, which in wet seasons was partially under water, and in the driest weather remained decidedly moist. Formerly this spot was a centre of attraction for butterflies, just as is the "Robin Hood" for human visitors to the Forest. But we found this once marshy patch dry, and not a single butterfly was hovering over it. Hence we fear that here, too, some draining operation has been carried on, though we scarcely see that the waters of this region can have been conveyed to that costly blunder the "Connaught Water."

In short, we cannot help concluding that the forebodings of our contributor, Frank Fernseed, expressed in June, 1882, have been in great part fulfilled. Very much has been done to convert Epping from a Forest to a Park. Formality and monotony have been inaugurated in place of freedom and variety. For a park—be it a peer's or a people's—is something essentially formal and monotonous, and we hoped that in Epping Forest the public would have had something very different. We should have felt little satisfaction had we known in what manner it was to be "conserved."

VII. THE NEEDLE ORDEAL IN WITCHCRAFT: NON-SENSITIVE POINTS OF THE SKIN.

WHILST it is well known that we perceive with the eye merely visual sensations, and with the ear only sounds, it is admitted that with what is commonly known as the sense of feeling we perceive an entire series of respectively heterogeneous sensations, for with it we recognise heat and its opposite cold, pressure, pain, &c. There can be no occasion to point out that these different sensations occasionally overlap each other. Thus temperatures differing too widely from the average condition of the medium in which we live occasion us pain; but any and every temperature, or change of temperature, is not necessarily recognised as pain or as its opposite. Certain degrees or modifications of pressure are felt as pain, but we cannot pronounce pressure and pain as one and the same thing.

In Physiology the view is commonly received, on the ground of observations and experiments on the organs of the senses, that each nerve can conduct only one specific kind of sensation and convey it to the central organ. Hence arose the problem for Physiology, either to show that there exist in fact, in the skin, special nerves for the different qualities of sensations, or to reject the law above cited as not universally applicable. It has been demonstrated by recent experiments that in fact, for some at least of the sensations mediated by the nerves of the skin, there exist especial terminal apparatus, and therefore probably especial conductions to the nervous centres.

Researches in this direction have been conducted by Herr Blix. More recently Dr. Goldscheider has independently examined this question, and has communicated his results in a memoir read before the Physiological Society of Berlin, and to the "Naturforscher." His investigation was conducted with a solid cylinder of brass, terminating in a rounded point. This instrument can be heated or cooled at pleasure, and is in connection with a writing-pencil. If the sensitive points are marked with colours, we can convince ourselves that only certain points of the skin are capable of recognising temperatures. Further, those which perceive cold (the cold-points) are separate from those which perceive heat (the heat-points). We presume that by cold and heat the author must mean temperatures respectively colder or hotter than that of the human body. On examining more closely the distribution of these points, it appears that they are arranged in chains which radiate out from certain points of the skin, and take generally a more or less curvilinear course. The chains of cold-points are mostly distinct from those of heat-points, but there occur occasionally mixed chains of both kinds of points. In the hairy parts of the body these chains radiate, with a striking regularity, from the hairs. In the hairless parts the arrangement is similar; there are radiating points at similar distances, as in the hairy parts. The prominent signification of the hair-places for the temperature-sense is visible in those regions which contain few temperature-points. Here it occurs that such points are found only at the hairs, whilst between them is everywhere insensibility against temperature.

The temperature-points are anatomically constant; for such points when they have been marked on the skin can be recognised as such, on a renewed examination, a long time afterwards. They may even be recognised after the removal of the epidermis, and they have consequently nothing in common with its thermic conductivity. The heat-points are everywhere less numerous than the cold-points. The number of the temperature-points altogether varies locally, and falls distinctly into the back-ground in those surfaces of the skin which subserve the sense of touch. The feeling which arises on irritating a temperature-point differs in strength at different points, and these require for their excitement a different degree of irritation.

A noteworthy property of the temperature-points is that a sensation of temperature can be induced in them by a gentle thrust with a needle or a pointed splinter of wood. It appears therefore that the temperature-point is a very well-defined anatomical point, since the sensation of temperature ensues only when the point is most accurately hit. In like manner the feeling of temperature proper to these points can be excited by means of induction-currents. On the other hand, it is found that the temperature-points recognise neither contact nor pain. The latter phenomenon is very distinctly demonstrated by means of a fine needle which is plunged vertically into the skin. Here also is to be noted the sharp limitation of the temperature-point.

If there are special nerves for the recognition of temperature, we must naturally expect that they will, so to speak, translate every sensation into the language of temperature, just as a blow on the eye is perceived as a flash of light, and pressure on the nerves of hearing is felt as a humming noise.

The fact that the temperature-points are insensible to pain reminds us of one of the traditions of witchcraft. Among the methods of recognising a witch it was customary to thrust pins or needles into different parts of the body. Witches, it was thought, had certain spots insensible to pain, and if the prick of a needle in any part was not felt the victim was at once condemned. In virtue of Dr. Goldscheider's researches we may say that these non-sensitive spots were simply the temperature-points, and that they would be found in all persons alike.

These experimental results permit the conclusion that the temperature-points present gaps in the sensitive field of the surface of the skin, filled up, on the one hand, with specific cold-nerves, and on the other with heat-nerves. Thus, as far as the nerves of temperature are concerned, the doctrine promulgated by Prof. von Helmholtz, that every nerve-fibre is capable of one only state of excitement, and consequently of only one quality of sensation, is fully confirmed. This view is further confirmed by the fact that Dr. Goldscheider has succeeded, by electrising the nerve-stems, in exciting very distinct peripheric sensations in the region of the nerves concerned,—the feeling of cold predominating. The same result has been obtained in some parts by pressure upon the nerve-stems.

In these topographic investigations it has been found that the heat-sense is less developed than the cold-sense, both in extent and in intensity. The temperature-points possess an exceedingly fine sense of locality. If two of them are irritated simultaneously, individual pairs of points can be recognised as twofold at very small distances, even to less than 1 millimetre. Such minimal distances differentiate topographically.

On the analogous application of pressure to certain points, certain such points of the skin have been found especially sensitive to pressure. The investigation was effected by means of an instrument consisting of a spiral spring supporting a needle, in which was fixed a small plate of cork, as well as a pencil to identify the points. These points can also be found by means of weak induction-currents. These points are not alone prominently sensitive to slight mechanical irritation, but they are at the same time the seat of a specific feeling for pressure; hence they may be characterised as pressure-points. This specific feeling is distinguished from that of the intervening skin by the distinct, acute, sensation of point-pressure; by the direct appreciation of the gradations of pressure; by the painfulness of strong irritation; and lastly, by means of their very distinct sense of locality. By means of a pair of compasses it was ascertained that adjacent points of pressure were felt as double, even at such small distances as 0·1 millimetre.

The pressure-points display the same type of arrangement as the temperature-points, but they generally stand much more closely together. They likewise are arranged in chains which radiate out from certain points, and quite especially from the hairs. At these parts there is often an agglomeration of pressure-points, and in parts which are little sensitive to pressure the immediate vicinities of the hairs alone possess pressure-points. In hairless places there are corresponding symptoms of radiation which in position correspond with those of the temperature-points. As regards their sense of locality, the remarkable phenomenon has been observed that pairs of points belonging to different chains have, in general, a more strongly developed sense of locality than those belonging to one and the same chain. This admits of the inference that the points belonging to one chain are in more intimate anatomical connection than those of different chains.

We see therefore that the skin contains, distributed over its surface, organs of at least two distinct kinds, each having its special inservation and its conduction to the nervous centres. We see, on the one hand, temperature-points, sensitive to heat or cold, but insensible to pressure or pain, and so specialised that heat and cold fall under the cognisance of distinct organs; on the other hand, we see pressure-points, very sensitive to pain and to pressure, but insensible to temperature.

VIII. FLOWERS AND INSECTS.

THE mutual relations of flowers and insects have given rise to no little ink-shed. They have been seriously studied by naturalists of merit—to mention names would here be invidious. They have been made the subject of smart "readable" gossip by *dilettanti*, and they have been altogether denied by certain "survivals." But since the death of Hermann Müller too little has been added to our solid knowledge on this most interesting subject. The reason why so little has recently been done in a region far from exhausted has been ascribed, on the one hand, to the difficulties of the statistical method, as used by Müller, and, on the other, to the circumstance that a combination of entomological and of botanical knowledge is here required. The observer must not merely be able to identify the flowers visited and the insects which frequent them, but he must be acquainted with the morphology of the one and the other, so that he may comprehend their mutual adaptations and the part their inter-relations have played in the evolution of varieties and species. Such a double acquaintance with flowers and insects by no means falls to the lot of every naturalist.

We may therefore congratulate ourselves that the question has been taken up anew by Prof. E. Löw. This investigator proceeds from a different point of view to that adopted by the late Hermann Müller, and has reached some exceedingly important results, which have been consigned to the pages of the "Jahrbuch des Botanischen Gartens, Berlin," and of the "Naturforscher."

Prof. Löw takes up in particular two questions: he examines the relation between the circle of visitants and the selection of flowers visited in a definite area of observation, whose constituents are heterogeneous, being accidentally made up of plants of very different origins. Secondly, he examines what colours, under otherwise identical circumstances, are preferred by the insect visitants. The field of observation was the Berlin Botanical Garden: 205 species of insects were noticed as visiting flowers,—namely, 102 Hymenoptera, 66 Diptera, 22 Coleoptera, 13 Lepidoptera, and 2 Hemiptera. This is about one-fourth of the species which Müller, in his work on the fecundation of flowers, mentions as flower-frequenters. We may here notice as somewhat extraordinary the paucity of butterflies and moths, especially as Germany is far richer in these insects than Britain. It is very probable, judging from our own observations, that if a plot of ground had been selected some 10 or 20 miles from any large town the proportion of Lepidoptera would have been greater.

Prof. Löw observed 2000 insect visits to 578 species of plants cultivated in the open air. The plants in question belonged to three distinct zones. The first zone comprised plants of the forest-territory of Europe and Asia. In the second group were included all plants of the Mediterranean region, and of Western Asia, a region whose insect fauna differs from that of Central Europe and Asia more widely than do the various parts of the Central European and Asiatic region from each other. The third zone comprised plants indigenous in America or Eastern Asia, whose homes have an insect fauna still more widely differing from that of Central Europe. Plants of other origins were not taken into consideration.

It is well known that Müller seeks to answer the question, what species of insects are especially active as pollen-distributors in a given kind of plant. Löw takes up the inverse question: what selection does each insect species make among the flower-forms and colours presented to its view? Such an examination of the subject from the entomological side was necessary, as only thus can a clear insight into the abundance of the facts be obtained.

In accordance with this principle Löw has arranged his materials not according to plant-species, but to insects. Hitherto only the first part of his researches has been made public,—that treating of the Apidæ. Of these he has observed 20 genera, with 77 species. The single genera and species are characterised by their distinctive features, and especially by those structural features which come into play in the collection of pollen and honey, and brought into connection with their activity in different forms of flowers. In connection therewith there is given for each species a list of its flower-visits founded on Müller's arrangement of flowers, —as wind-flowers (anemophilous), pollen-flowers, flowers with their honey open, partially concealed, or fully concealed, flower associations, fly-, bee-, and butterfly-flowers.

First in the series of flower-visitants ranks the hive-bee, *Apis mellifica.* Its trunk, neither too long nor too short, affords the best conceivable equipment, by the aid of which it surpasses all its rivals in the number of flowers which it can utilise. It is the most skilful of all flower-visitants, being able not merely to distinguish the exceedingly manifold arrangements of flowers, but to utilise them most advantageously by modifying its procedures. Of the flower-visits observed by Müller in Northern and Central Germany, 36·3 per thousand were effected by the honey-bee. Löw's observations give a proportion three times greater,—a result due to the peculiar locality.

Nevertheless, as regards the selection of flowers, there is little difference between these two authorities. Müller's observation, that any class of flowers is visited the more rarely the opener its store of honey, was fully confirmed. These and other facts prove that all doubts as to the trustworthiness of the statistical method must be considered unfounded.

An especially striking fact established by Löw is, that of the nine kinds of *Bombus* which he has observed, and which may be arranged according to the length of their trunks in an ascending series from *Bombus terrestris* to *B. hortorum*, show a similarly progressive preference for "bee-flowers."

The following facts, advanced by Müller in support of his theory of flowers, have been fully confirmed by Löw in his limited field of observation:—

1. The more openly a class of flowers presents its honey the more it is visited by species with short trunks; the more deeply the honey is concealed the more it is frequented by visitors with long trunks.
2. The more a flower-visitant is furnished with a short or a long trunk, the more decidedly it prefers flowers with open, or respectively with deeply-concealed, honey. In visitants with long trunks, however, in

case of an increased demand for nourishment (as in hive-bees and hummle-bees*), a more or less general utilisation of flowers whose honey lies exposed is observed.

3. Visitors with short trunks prefer flowers of light colours,—white or yellow. Species with long trunks prefer dark-coloured flowers,—blue, red, violet. Species very eager for food visit a more promiscuous circle of colours.

To these propositions may be added a fourth, which, though rendered probable by Müller, was not demonstrated, —that a disharmony between the adaptation of flowers and the sphere of action of the agents in crossing may appear if the circle of visitors is subsequently modified, *i.e.*, by the distribution of plants in a new territory. Löw observed that the species of *Apis* flying in the Botanical Garden made a different selection among exotic flowers from amongst native species. They select, indeed, the classes of flowers of the Mediterranean plants in the same serial order as those of Central Europe, but their preference for "bee and hummle flowers"—consequently for flowers with dark colours—is increased about 20 per cent. Very different is the proportion among American species. Here the light-coloured flower associations seem to attract bees most strongly. This behaviour may be explained by the circumstance that among the North American plants cultivated in the Botanical Gardens the yellow Compositæ predominate, whilst among the Mediterranean species "bee and hummle flowers" are most numerous.

An important result of these researches is that the selection of flowers and of colours is not, as Müller supposed, determined absolutely by the length of the trunk. This is proved by the fact that different Apidæ, with trunks of equal length, make a quite different selection. Löw terms this phenomenon *heterotropism*. He terms species which give an exclusive preference to certain flowers *oligotropic*, and those which proceed otherwise *polytropic*. The most distinctly oligotropic species is *Anthidium manicatum*, and the most polytropic is *Apis mellifica*.

In almost all genera of bees there can be shown a factor which, in conjunction with the length of the trunk, determines the peculiar selection of flowers. As such may be mentioned the early or late time of flying (*Osmia rufa*, *Anthophora pilipes*); an increased demand for nourishment (*Apis*, *Bombus*); great demand for pollen (*Heriades truncorum*, *Prosopis*); peculiarities of the structure of the nest (*Anthidium manicatum*, which has a short trunk, lines its nest with the woolly hairs of leaves, and consequently prefers the hairy Labiatæ to the Papilionaceæ, though it could obtain honey much more conveniently from the latter).

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* The *b* commonly figuring in hum*b*le bee is an error. The *h* also is rightly aspirated, as the word has no connection with *humilis*.

Müller recognised to some extent the influence of such factors, yet he laid far too little weight upon them, though their importance can be shown from his own statistical results. It appears therefore inadmissible to found the progressive development of flowers and insects solely upon the elongation of the trunk. In this respect Müller's theory is in need of modification.

ANALYSES OF BOOKS.

Spectrum Analysis in its Application to Terrestrial Substances, and the Physical Constitution of the Heavenly Bodies. Familarly explained by the late Dr. H. SCHELLEN. Translated from the third enlarged and revised German edition, by JANE and CAROLINE LASSELL. Edited, with Notes, by Captain W. DE W. ABNEY, F.R.S. Second Edition. London : Longmans, Green, and Co.

A WORK on Spectrum Analysis may be either devoted to a description of the various forms of the spectroscope, and the precautions to be observed to ensure success in their employment, or it may discuss the results obtained in various sciences by the use of this instrument. The volume before us to a certain extent combines both these features. At least to a very full explanation of the fundamental principles upon which spectrum analysis is founded, and to an account of most of the existing types of the spectroscope, it adds an elaborate exposition of our present knowledge in what may be termed celestial chemistry. On the contrary, the reader who seeks for information on the use of the spectroscope in organic chemistry, or in biology, will find comparatively little to suit his purpose. As an important feature—not to be found in many physical treatises—may be noted, with approval, the very sparing use made of mathematical formulæ. Too many writers on such subjects, we fear, instead of using such formulæ merely where and in so far as it may be necessary for explanation, invert the matter. They seek to make phenomena merely a peg on which to hang a maximum of mathematical discussion. By so doing they succeed to a marvel in making themselves unintelligible to all save specialists.

The present work is divided into eight parts. The first part discusses the artificial sources of high degrees of light and heat, such as the Bunsen burner, the electric spark, the voltaic arc, &c. The second bears the heading " Spectrum Analysis in its Application to Terrestrial Substances." But it includes also the theory of light, an account of refraction of the solar spectrum, and of the dispersion of light. It would be needless to enumerate the different kinds of spectroscopes which are here described and figured. Only eight pages are devoted to the absorption of light by liquids, and the micro-spectroscope is treated much more briefly than in Mr. Suffolk's little work.

The remaining five parts or chapters, forming the larger portion of the book, deal with celestial spectroscopy. Here, however, there are also included sections on telescopic appearance of the sun's surface, and speculations as to the nature of the solar spots founded upon telescopic observation.

Here, therefore, we are landed on what is somewhat profanely called "sunspottery." The history of opinion on these much begossipped phenomena is briefly given. Pastor Schülen, of Essingen, in 1770, is said to have been the first who pronounced these spots to be depressions. The same view was held by A. Wilson and the elder Herschel, and, though we find it stated in the text that "opinions are still divided as to whether the spots are cavities or not," yet the Editor appends a note which seems to answer the question in the affirmative :—"At Kew and Greenwich photographs have been obtained when a spot was just at the limb. One or two photographs show notches cut out of the limb due to the depression of the spot." The conflicting theories of Spörer and Zöllner, on the one hand, and of Secchi on the other, concerning the causes of the spots, are summarised, but no positive conclusion is drawn,—a judicious reservation. The question which is most closely linked with sun-spots in the public mind,—*i.e.*, the connection, real or supposed, of their periodicity with a variety of terrestrial phenomena,—lies, strictly speaking, outside the plan of the present work, and is therefore not entered upon. On this subject we may refer to a brief note in our "Correspondence" department.

The succeeding chapters treat of the applications of spectrum analysis to the moon and planets, to the fixed stars, the nebulæ and clusters, comets and meteors, the zodiacal light, aurora borealis, and lightning.

The value of this work to all who are interested in celestial phenomena—and who is not?—is incontestable. On this part of the subject it may claim an almost encyclopædic position. The illustrations are excellent and very numerous. There are fourteen maps and plates, five of which are coloured, and 604 woodcuts introduced along with the text.

The Wave of Translation in the Oceans of Water, Air, and Ether. By J. Scott Russell, F.R.SS. L. and E. London : Trübner and Co.

The author of this work divides water-waves into four orders. The first is the wave of translation, the second oscillating waves, the third capillary waves, and the fourth the corpuscular wave. As instances of the first order he mentions the tide-wave and the aërial sound-wave; of the second, wind-waves and the ocean swell; of the third, dentate waves and zephyral waves; of the fourth, the water-sound wave. He considers that an intimate acquaintance with the nature and the laws of the wave of translation will "in the future render great service to researches in physical and chemical science." He applies his knowledge of this wave primarily to the doctrine of sound. He considers that the phrases "waves of sound," "oscillations of air," &c., are used too generally and vaguely, and applied in a misleading manner. His own view is that each separate sound has one solitary wave of its own, which goes out from the source of sound along one straight line in a given direction, carries the impulse it receives, from whatever source, with a given velocity, and delivers into the ear the single impulse it receives. It is thus one single complete phenomenon."

Incidentally and mainly, as an illustration, he points out that if the contents of an elevated reservoir are suddenly and at once discharged into a canal, they will do at the other end of that canal far more work than if permitted to flow in slowly. In the former case there is no loss or waste of power except the small waste by friction. In the latter case nearly the whole of the useful power is wasted. This is a consideration of importance.

In Part III. the author treats of the "Great Ocean of Ether and its Relation to Matter." Here we find some questionable chemistry. Mr. Russell writes:—"The air we breathe is oxygen and nitrogen. The nitrogen we breathe out finds its way into the plants which want to take it in." But the nitrogen we breathe out, like that of the atmosphere which has never passed through our lungs, is incapable of being absorbed and assimilated by plants. The author continues:—"All trees and vegetables are almost entirely made up of these four elements, hydrogen, oxygen, carbon, and nitrogen, and, to convert these into the matter of which all animals are made, we take the elements of that same vegetable matter, and add to them a small quantity of one or more of the sixty other substances which, as far as we know, comprehend the whole universe." This passage seems to convey the erroneous view that animals and plants differ qualitatively in a chemical point of view.

We regret that the space at our disposal does not permit us to carry any further our examination of this work.

The Revival of British Industries the most Important Question at the approaching General Election. By A CANDIDATE. London: James Bolton.

THIS pamphlet does not fall within our legitimate purview.

Scientific Romances, No. II. *The Persian King, or the Law of the Valley.* By C. H. Hinton, B.A. London: Swan, Sonsenschein, and Co.

Some time ago we had the pleasure of noticing the first of these "Scientific Romances" from the pen of Mr. Hinton. Concerning the purport of that treatise not the slightest doubt could exist. Some persons might be led by its reasonings to an acceptance—transitory or persistent—of the conception of space and matter as four-dimensional or even *n*-dimensional. Others might doubtless throw it aside as an idle though ingenious paradox. But all alike would see, at least, what the author was seeking to prove. But in the work now before us the case is very different. There is no one interpretion of the allegory which will force itself upon all readers as the only one possible. One interpreter may say that the author is combatting the notion of energy running down and of the universe being gradually resolved into a *caput mortuum*, as the old alchemists would have called. Another, basing on p. 127, lines 1 to 4, may see here an assertion of "substantialism" of the existence of imponderables. A third fixing his attention on the lower part of the same page, and on certain corroborative passages elsewhere, might contend that Mr. Hinton's main object was to explain the Divine action in the government of the universe.

Yet another plausible interpretation is that the author is expounding the relations of pleasure and pain, arguing that just as action and reaction are equal and opposite, and that as a semi-oscillation of the pendulum pre-supposes the other half, so every pleasure felt in the universe involves a certain corresponding amount of pain in the same sentient being or in some other. This might, perhaps, be expanded into a theory of one of the mysteries of the world, vicarious suffering. But if pleasure necessitates pain, pain must also necessitate pleasure. If we bear pain, or inflict it upon ourselves, do we give a corresponding amount of pleasure to some being? If so, we have a philosophy of asceticism. But if we inflict pain upon some one being, A, do we not in like manner then occasion pleasure to some other being, B? Singularly enough the ascetic or self-tormentor is, we believe, without exception, the first to torment others.

But leaving such rambling speculations, let us ask whether pleasure and pain are of necessity equal and opposite, lying, like the semi-oscillations of a pendulum on opposite sides of some neutral or zero point? We think not universally so. For pain is often merely the intensification of a feeling which in lower degrees is pleasure. If we suffer from cold we hold our hands or feet to the fire, and we feel pleasure in so doing. But if we hold them gradually nearer and nearer, or if the fire is urged to a fiercer heat, we find the pleasure gradually passes into pain, Pleasure and pain, then, in some cases at least, lie on one and the same side of the zero-point. There are further, many parts of our bodies very capable of experiencing pain, but quite incapable of pleasure. When working in their optimum condition under normal circumstances we are not conscious of their existence. On one side of the zero-point there is, to our knowledge, nothing. Further, as far as we are capable of tracing, the intensity of pain is far greater than the utmost intensity of pleasure. What pleasure is as great a departure from the zero-point on the one side as is violent neuralgia on the other? But very possibly we are questioning propositions which Mr. Hinton does not affirm.

He writes—"Does this will not exist in those who are true personalities, and not mere pleasure-led creatures?—have they not some of this power, the power of accepting, suffering, of determining absolutely what shall be?—a creative power, which given to each who possesses it, makes him a true personality, distinct, and not to be merged in any other—a power which determines the chain of mechanical actions, of material sequences —which creates it in the very same way in which it seems to be coming to an end—by that which represented in material terms is the absorption of energy into an ultimate medium, which represented in terms of sensation is suffering, but which in itself is absolute being, though only to be known by us as a negation of negations."

Cremation. By J. G. Davey, M.D. Read at Meeting of Bristol Medico-Chirurgical Society. Reprinted from the "Bristol Medico-Chirurgical Journal."

The author of this pamphlet remarks that in our great cities at least the disposal of the bodies of the dead is becoming, or is already, one of the most pressing questions of the day. The great work which Dr. George Walker—familiarly known as "Churchyard Walker"—began and carried through near forty years ago is to do over again. What the old urban grave-yards were then the suburban cemeteries are now, or are fast becoming. They are being surrounded by the habitations of the living, their drainage soaks into the earth and saturates it with the products of putrefaction and with disease-germs, or finding its way into the sewers it sends off volatile matter, which, through sinks, baths, and water-closets, find access to our houses. Unfortunately, too, many of our cemeteries have been placed, as if for this very purpose, upon eminences. We find here mention of a fact of which the public are certainly not aware. Speaking of the cemeteries at Highgate, Kensal Green, and Brompton the author says:—

"These burial-places, it should be known, were condemned in 1850, by the Board of Health, and ordered to be closed, in the interest of the public health, but to this day they remain *unclosed*. The last-named cemetery was bought by Parliament, yet the Government of the country is now using it 'at high pressure and remunerative rates,' though 'condemned' by its own Board a generation since!"

We must here pause to make a remark. An offensive and dangerous grave-yard, it appears, has privileges unlike any other nuisance. Take an ill-managed manure-works, or a sewage-polluted river. The owners or other parties occasioning the nuisance receive at once peremptory orders to discontinue or abate the same, and are liable day by day to a penalty until the evil complained is removed. If this is not feasible the works may be stopped altogether, no matter at what loss to the owners. Nay, we have heard of a case where a verdict of manslaughter was duly returned against the proprietor of a manure-works, it having been shown that certain deaths had been at least accelerated by the fumes given off. But we believe that when a grave-yard or a cemetery is found to be a nuisance, and is closed accordingly, its owners, so far from being liable to any penalties for past mischief are considered entitled to "compensation." This is one of those pieces of inconsistency in which John Bull delights.

We are glad to find that in this pamphlet Dr. Davey, unlike the bulk of modern sanitary authorities, distinctly admits the merit of G. Walker as the reformer of our grave-yards,—a merit too often ascribed to others, who shine, if at all, merely by reflected light. But a quite different reform is now necessary. If the dead are to be carried out to such a distance that the cemeteries shall be in no danger of being surrounded by houses, the cost of funerals, already a heavy burden for all but the wealthy, will be greatly increased. One escape, and one only, is open. In the words of the Rev. H. R. Haweis here quoted—"The pure fire-angel of cremation stands now at the door." It is proved that the microbia of infectious diseases are not destroyed by burial. They multiply in the putrescent corpse, and the earth-worms, as it has been distinctly shown in Pasteur's experiments, bring them up to the surface. When once there the flies, *colporteurs* of fever and pestilence, do the rest.

We are far from asserting that cremation is without its difficulties. But in the three weightiest points, public health, economy of land, and decrease of funeral expenses, its advantages are indisputable.

Our Corner. Vol. VI. No. 1, July 1, and No. 2, August 1, 1885. London: Freethought Publishing Company.

THESE two issues are, in our opinion at least, much more interesting than the generality of their predecessors. Or, to say the same thing in other words, they are less exclusively political.

The papers by Mrs. Besant on the "Evolution of Society" contain many truths which, if not always novel, need repeating with ever increasing emphasis so long as they pass unnoticed. The author shows that our modern industrial organisation is not in all respects an improvement. She writes:—"In consequence of the slight division of labour there was a pride in capable workmanship which is now almost impossible. Individual ability, under this system, was at once apparent and had scope for development, so that art and industry were more closely united than they have ever been since. The artist (*e.g.*, Benvenuto Cellini) was largely a handicraftsman in the industrial sense, and the handicraftsman was largely an artist (sometimes the one was transformed into the other, as in case of Quentin Matseys), and side by side with this mental development existed physical vigour in consequence of the small size of the towns and the accessibility of the open country." Who dares deny all this?

The writer shows that the result of machinery "should have been wide-spread comfort and a great diminution of the hours of labour; the result of it has been the accumulation of vast fortunes by a comparatively few, the deadening and the brutalising of crowds of the handworkers. Whether we regard the immediate or the general results we shall find them very different from the rosy hopes of those who gave to the world the outcome of their inventive genius." These truths are expounded with much ability and with a wealth of illustration. But why has machinery been put to the wrong use? Simply from human greed. Instead of producing the same quantity of goods as before in less time, men preferred simply to increase production. It has been said that machines are like slaves, and the resemblance goes further than was supposed. In the Carolinas, besides the slave-owner and the slave, there was merely the "mean white," and the tendency of machinery as now applied is to reduce all who are neither capitalists nor "hands" to the position of "mean whites." Sanitary reform is strenuously insisted on. It is urged that "a high human type cannot be bred in a slum, trained amid filth and ugliness and clangour, sent to labour ere maturity. . . On the faces of the lads and lasses who come tumbling out of factories and warehouses at the close of every day, filling the streets with tumult and horseplay, is set the seal of the sordid conditions under which they live." We could say more on this subject did our allotted space allow us.

"The Population of a Peepul-tree," by C. Bingham, is a sound, original study in Natural History. The author evidently resides in Burma, where there is much to be seen not yet recorded. He notices *Ficus laccifera* as yielding caoutchouc quite as good as that of *Ficus clastica*, but strangely overlooked. The tenacity of life of the *Ficus* genus and their power of destroying other trees and even buildings are ably and correctly described. The account of the Bahalias catching birds on trees with rods smeared with bird-lime is decidedly painful. The author remarks that "paroquets, notwithstanding their large brains, are foolish fowl after all." Continuing his notes in animal psychology he tells us that "*Semnopithecus cristatus* is far inferior in intelligence to the common fishing monkey (*Macacus cynomulgus*), and this is strange, for the skull of *Semnopithecus* has a far better shape, and is not nearly so retreating, as that of the *Macacus*."

The peepul-tree was, we are told, simply alive with birds. The tailor bird (*Orthotomus sutorius*) has profited by civilisation. As is well known it sews leaves to form its nest. In gardens it often discards the rough fibres produced in the jungle, and uses cotton thread stolen from the house. The thread is knotted at one end, passed through both leaves, drawn tight, knotted again, and the remainder cut off.

Butterflies in numbers were attracted apparently by the heavy odour of the peepul fruit.

The fire-ants, *Formica smaragdina*, notwithstanding their ferocity, are preyed upon by a *Mantis*, which mimics them so closely that it is able to approach a stray ant without being detected until too late.

Two mud-building solitary wasps, one red-brown and the other a deep blue, are a pest in Burma from their habit of stopping key-holes with their clay nests. One of these nests of three cells was seen to be built and provisioned in 2 hours 7 minutes. We hope we have not heard the last of Mr. Charles Bingham.

Mr. J. Horner contributes two sound articles on "Work for the Microscope," in one of which he treats in a very practical manner on the collection of specimens which may serve as objects.

Mr. John Robertson is the author of two papers of singular ability. The first of these, "Concerning Ritual," we were about to pass over as not coming within our scope. We found, however, that he raises the weighty question whether in these days man is becoming more or less differentiated? Whether individuality is waxing or, as Stuart Mill contended, waning? Mr. Robertson rejects the view of Mill, and in some respects he is right. But he omits one factor which tends to increase monotony in character: the examinational tendency of modern English education. It is somewhat singular that none of the organs of Freethought, as far as we are aware, ever raises a protest against this bureaucratic system.

The article winds up with a scathing exposure of positivism. Mr. Robertson writes:—"An enthusiastic system-maker proposes to undermine once for all the dominion of supernatural religion by teaching men that humanity should be the object of his devotion rather than God. And how does he think to work out his purpose? By giving men a code ordering for one and all their whole lives, and fixedly ordaining alike the time to be given daily to the ritual of the new religion and the distribution of that time in detail. Setting out with the avowed object of cultivating devotion to humanity, Comte assumes that men cannot stay in the right attitude unless they keep constantly repeating formulæ; praying at fixed hours and distributing their prayers in fixed arithmetical proportions; reverencing mother, wife, and daughter, *in the abstract*, so many hours by the dial; doing honour to particular men on particular days all the year round; taking their poetry and music by the calender: and this not according to their own choice, but comformably to a table drawn up for their use—turning themselves into something like the praying-wheels of the monks of Thibet. This, forsooth, is the way to make men free and wise and self-controlled,—this paralysing of every spontaneous emotion, this tabu of all originality, this elaborate extirpation of the faculty of individual judgment! . . It is the very mania of pedantry, the very insanity of formalism."

Mr. Robertson's second article, "The Ethics of Vivisection," is far too important to be noticed at the conclusion of a slight critique like the present. If possible it will be made the subject of an article in our October number.

Once a Month: A Magazine for Australasia. Vol. II., No. 6. Melbourne and Dunedin: Inglis and Co. London: Griffith, Farran, and Co.

THERE is much in this magazine upon which we are not at all competent to pass an opinion. "Sounds and Sandflies" is an interesting survey of a beautiful region on the west coast of New Zealand, endowed with charms innumerable, but cursed with the multitudinous presence of one of the most offensive forms of man's eternal enemy—the Diptera. Sandflies generally—why so named we know no more than the writer of the paper before us, since they are by no means confined to sand—are of all Diptera the most detestable. Their European representative (*Simulium Columbaczense or Rhagio Columbaczensis*) of southern Hungary is a fearful scourge alike to man and beast, but from the description here given of the New Zealand species it is certainly not less to be dreaded. Various remedies or preventives seem to have been used by the party whose adventures are here described, but all it would seem unsuccessfully. Amongst them is mention of a tincture of rosemary. The question suggests itself, was this garden-rosemary, or the very different plant marsh-rosemary (*Ledum Palustre*)? From personal observation we know that the tincture of the latter plant is a protection against mosquitoes, and we shall be much disappointed if it fails as against the New Zealand sandfly. We see no mention of the tincture of *Pyrethrum roseum* having been applied.

It is much to be regretted that so few inventors turn their attention to means of repelling or destroying the blood-sucking Diptera. It is not too much to say that over three-fourths of the habitable globe human life is more or less embittered by these pests.

The origin of their blood-sucking instinct is an uncracked "nux zoologica." Here are creatures not dependent upon human or mammalian blood. Indeed, millions of them and of their progenitors for generations must in such localities as the Western Sounds of New Zealand never have seen or smelt a mammal. Yet on the very first approach of a man they flock to him as if blood was a necessary to which they had always been accustomed! Their supposed sanitary services are so far from being established that the very contrary view is almost absolutely demonstrated,—that they are the *colporteurs* of zymotic disease. Surely in view of what we know of the *Culicidæ* and *Tipulidæ* the "pious adage" that everything is of some use becomes very questionable.

In "Adventures of a Pioneer" there is mention of a tree called "the native Peruvian bark tree." The bark is said to contain a large proportion of quinine. Whether this tree is near of kin to the Cinchonaceæ it does not appear. We read further some particulars of a beautiful tree which has been named in honour of Professor Owen. It appears that it propagates only by suckers which spring up from the roots. The seeds will not germinate. They are contained in a solid stone, so dense that "it cannot be broken with a hammer." Two years must pass before the stone decays, and then the kernels have perished also. Surely a curious state of things to have been reached by natural selection or any other process!

But this is not the only interesting fact which the author of this paper has to relate. The Bullogurra lake is an exception to the rule that all lakes and depressions which have no outlet should be salt. But at a depth of 12 feet below the fresh water is a bed of ground-water much more than twice as salt as the sea.

A species of wild clover or trefoil growing on the margin of the lake is infested with a dark-coloured aphis. "Horses feeding amongst it are attacked by the aphides, but only when they have white spots on their noses or feet." This the author justly pronounces "a new and extraordinary fact in natural history." But that our common green aphis is capable of attacking man we know from recent experience. Passing under some lime trees we felt an irritation on the back of the left hand, much like that produced by the bite of a gnat. On looking we found that an ordinary green aphis in the winged state had settled on the spot. We brushed away the intruder, but the feeling of irritation remained for upwards of an hour.

A burrowing marsupial animal something larger than a rabbit was captured. It is the Betu of the blacks, and does not seem to have been often met with.

In a medical article entitled "Our Doctor" we note the very sensible remark :—"The special disease of modern life is worry." When will the believers in "progress" learn that they are moving in the wrong direction?

"Once a Month" has our best wishes.

Revista Internacional de Ciencias Médicas y Biologicas, fundada par Don Carlos de Vicente y Charpentier. Vol. I., No. 1. April 15, 1885. Madrid: Tipographia de los Heuérfanos.

THE successive chapters of this journal are devoted to medical physics, chemistry, microbiology, anatomy, physiology, therapeutics, medicine, neurology, surgery, obstetrics, hygiene, ophthalmology, and syphilography. Embryology, taxonomy, general psychology, palaeontology, and organic geography do not, if we may judge from the number before us, come within the plan of the journal. Anatomy, too, appears to be treated exclusively from a medical point of view, and with reference to mankind alone.

Hence for the non-medical biologist this journal offers little interest.

The Ecclesiastical Gazette.

IN this paper we perceive the notice of a book by Mr. W. Arthur entitled "Religion without God and God without Religion." The reviewer writes :—"A recent controversy in the 'Nineteenth Century' has revealed the existence of three schools of thought among modern positivists, championed respectively by Mr. Frederic Harrison, Mr. Herbert Spencer, and Sir Fitzjames Stephen."

We are far from accepting the tenets—especially those more recently developed—of the "Dux Syntheticorum," but we do not think that they can be at all rightly characterised as positivist. The differences between the views of Auguste Comte and Mr. Herbert Spencer are fundamental.

CORRESPONDENCE.

, The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

SCIENCE—PHYSICAL AND MENTAL—A SELF-INSPECTION.

In last month's "Journal of Science," as well as on several previous occasions during the last few years, I have endeavoured to set forth, as simply as possible, the above position under the term Hylo-Idealism or Phreno-Cosmism. In its ultimate form this only means that, while in no sense denying an outer world, it can impossibly be anything separate from the Self,—the two being strictly *solidaire*,—so that it really is a pre- and indeed anti-scientific heresy to speak of externality in a syntaxis which, though seemingly double, is really single, and therefore logically admits of no such duality. Subject and Object, to use convenient terms, thus merge in an actual *Auto-morphosis* or Self formation, or Creation. Thus all the world with which we have to do is a relative and phenomenal one,—in other words a phantom, symptom, spectrum, or idea of each formative mind,—a state of Consciousness, nothing outside that snbjective sphere, and which Science, now-a-days, *must* identify with Cerebration. On this thesis—the *data* for which seem utterly irresistible at our present standpoint both of Physical and Mental Science—Materialism seems victorious along the whole line, and Spiritualism, or Supernaturalism, in any shape, seems utterly put out of Court; relegated completely to the same limbo as Astrology, Alchemy, and other *Pseudo*-sciences and Black Arts. Matter and Force—so called, living and dead, a distinction without difference, since the artificial manufacture of *urea* and other organic compounds—proclaim themselves sole masters of the field of knowledge; what has been mistaken for Spirit being material energy, force, or action, the product, not the source, cause, or active agent in all operations, organic or inorganic, and which, as the special vitality of the Brain, cognised as Mind, with its other cognomens of Soul, Spirit, &c., which are really material not "spiritual" terms. In no language framed by man has it been possible to invent phraseology to distinguish such non-entities, of which human reason can take no account whatever. Man thus can think nothing higher than Self, and all notions that thus transcend humanity are seen to be Utopian dreams of its non-age. As I have before stated, this vital theory seems to be the only equitable one. As centripetal it confines our activity strictly within the confines of Self, any other which transcends such natural limits being demonstrably incompatible with just views of personal responsibility and free will, to say nothing of its incoherence. Religion thus, as Self adoration, quite disappears. Hygiene, or complete culture of body, intra- as well as extra-cranial, is its more than substitute.

ROBERT LEWINS, M.D.

MR. O. DAWSON ON DARWIN'S MASTERPIECE.

WITHOUT intending to decide whether Mr. Dawson, in writing the article which figures in your last number, had any other object in view save to damage Darwin's reputation (a question more difficult than important), I must beg leave to call attention to a passage of apparently wider scope. Mr. Dawson asks—"When will these blind partners, tottering Theism and capering Agnosticism, curvet together into the proverbial ditch ?"

I ask, supposing Theism and Agnosticism both disposed of, what remains ? Blank, dogmatic Atheism, which is fast becoming recognised by all minds above the "Cat and Ladle" level as simply unthinkable, or perhaps Positivism. Now Positivism must either deny the existence of any Being higher than man, or it must declare that we know nothing about such a Being. In the former case it is simply Atheism, in the latter a form of Agnosticism !

T. G.

DARWIN AND MR. OSWALD DAWSON.

IN the very curious article by Mr. Dawson which you have thought proper to insert at the beginning of your issue for the present month, I note the following most curious passage :—"It has been proposed that in that edifice [Westminster Abbey] a medallion be placed, purchased with a margin of the Darwin Memorial Fund not absorbed by the statue or devoted to the promotion of *biological* [italics Mr. Dawson's] research, in honour of the writer on Coral Reefs, Volcanic Islands, South American Geology, and the Formation of Mould." It will be, I hope, no breach of courtesy to remind Mr. Dawson of the open fact that Darwin is also the writer on the Movements and Habits of Climbing Plants, of a monograph on the Cirripedia, on the Fertilisation of Orchids, on the Expression of Emotions in Man and Animals, and on the Variation of Animals and Plants under Domestication,—all *biological* works. Mr. Dawson will also find, if he reads the treatise on the Formation of Mould, that this is distinctly a biological work, since that formation is traced to the action of an animal.

F. E. S.

THE PROPORTIONS OF THE SEXES.

A correspondent in your August issue (p. 497) suggests some very interesting experiments in incubation. In insects the sex of an individual seems not to be determined until towards the end of the larval stage. At least entomologists who rear moths and butterflies contend that when the food-supply is scanty the majority of perfect insects produced are males, whilst if food is superabundant females preponderate. In the human species the respective proportions of male and female children are neither alike in all countries. Unless my memory deceives me the proportion of male births in England is increasing, and the total birth-rate during the last few years decreasing,—both matters for congratulation.

Zero.

THE BALANCE OF NATURE.

That "numbers invite enemies," as your correspondent H. Browne says, is undeniable. The pests which ravage the vegetable world seem to have only assumed formidable proportions since fields, plantations, and orchards afforded them scope. There can be no doubt that Aphides are far more plentiful in England now than they were half a century ago. The rose-growers whom I knew in my young days had little trouble with "green-fly," but their successors have to play away with soap-suds and water, as if upon a conflagration, to keep their rose trees clean. This year a black Aphis is in fashion.

Richmond.

INSANITATION AT THE WEST-END.

WE dwellers in modern London often hear with wonder, indignation, and transitory good resolutions, of the conditions under which too many of the poor are at present living. But what shall we say if told that in many of the most sumptuous mansions at the West-End a part of the inmates exist under sanitary conditions equally bad? Yet such is the fact: the kitchens and their appendages are, in the more favourable cases, placed in a scantily-lighted sunk storey, in which ventilation without special machinery is impossible. But in other cases they are without windows, and are lighted by gas in both day and night. I have heard of a case—I fear not solitary—in which the cook had no other sleeping apartment save the kitchen (!), her bed being contained in a kind of chest which was drawn out of a recess when the day's work was at an end. The other servants, male and female, slept also in underground cells devoid of light and fresh air. As to the "sanitary arrangements," euphemistically so called, as you remark on a former occasion, they are as inadequate and ill-kept as they could possibly be in any tenement dwelling, or in the establishment of any "monopolist draper." Of all these abominations the master and the mistress of the house know nothing, and it is only the family doctor who ever suspects what kind of life there is below-stairs. He, too, must speak with bated breath, or a less observant practitioner will speedily be consulted in his stead.

Now I agree with the views developed by you in a paper on the "Limits of Sanitary Reform," that an occasional pestilence is a smaller evil than conditions which gradually sap the vitality of *any* portion of the community, and cause them to transmit enfeebled constitutions to the next generation. I hold that no person should under any pretext place a number of his countrymen and countrywomen in conditions where health and vigour are impossible.

But I may appeal not only to the conscience, but to the fears of the occupiers of such dwellings. It is surely neither safe nor pleasant to consume food prepared in such atmospheres as that which I have described. It is surely unsafe to live and sleep above subterranean dens of the kind just mentioned. Unpleasant—perhaps infectious—fumes and germs *will* ascend, and occcasion mysterious and unaccountable outbreaks of sickness. Dr. B. W. Richardson was not wrong in recommending that in all large mansions the kitchen should be in the topmost storey.

S. D

SUN-SPOTS AND THE WEATHER.

Before ascribing to the sun's spots, or to the conjunctions of the planets, or to any other cosmic cause, a decided influence upon the weather, we must surely be able to show that any given season is exceptionally hot or cold, wet or dry, as the case may be, over the whole world, or at least over an entire hemisphere, northern or southern. But we find no such uniformity. If we look at the last winter, we see it mild in Britain, exceptionally rigorous in Spain, especially in Granada at the time of the disastrous earthquakes, in Southern France, Austria, and in the United States.

Turning to the present summer we find it abnormally cold and wet in Iceland and on the west coast of Norway, cold and dry in Britain, the polar current prevailing in July and August, and unusually cold in South Africa, which is of course now having its winter. Yet all the while Russia is having a season not merely dry, but abnormally warm, to such an extent as to injure the grain crops.

Similar discrepancies between the weather in the East and in the West of Europe have been noted in former seasons. What, then, can be the meaning either of the scarcity or the abundance of sun-spots?

Cloud-Gazer.

SPIRITUALISM AND SCIENCE.

It would be unwise were I to defend the position which I took in my article in your July number without awaiting the finishing of the reply by "The Author of Scientific Materialism." But I cannot help referring to one of the misconstructions of my views in which Mr. A. R. Wallace has indulged, in his paper in "Light" for July 11th. I nowhere assert or imply, as he puts it, that "if Spirits exist and communicate with men they *must necessarily* know more of the material universe than men do, and *must* communicate their superior knowledge to us."

Now Swedenborg represents his Spirits as giving particulars concerning Jupiter and Saturn,—not too harmonious with the results reached by modern astronomical research,—and consequently as both knowing more of the material universe than men and as being willing to communicate such knowledge. I merely point out the improbability of such Spirits being either totally ignorant of the very existence of Uranus and Neptune, or being unwilling to communicate it. This point has been raised by others before me (without any reference to Spiritualism), and it has been generally accepted as fatal to Swedenborg's alleged revelations.

R. M. N.

"R. M. N" ON SPIRITUALISM.

I SUBMIT that your correspondent R. M. N. verges upon inconsistency. He evidently admits the alleged Spiritualist manifestations; he says that "there is nothing to be gained, and possibly there may be much to be lost, by persisting in an attitude of blank sweeping denial." Yet in the sequel he evidently takes a position hostile to Spiritualism.

A LUCRETIAN.

NOTES.

The Metropolitan Board of Works obstinately persist, at a cost of from £3000 to £4000 per week, in their attempts to "deodorise" the Thames.

An "electric girl" is now being exhibited at the Albert Palace. A writer in a contemporary received a "violent shock" on taking hold of her hand, and on putting a finger into a glass of water in which this girl had placed hers "the shock was almost stronger." (!) A man who felt nothing is accused of stupidity for saying "You must all have fancied it." Has any competent electrician observed and measured this electric action?

In the "American Naturalist" A. L. Ewing describes a hermaphrodite crab (*Callinectes hastatus*), in which, however, neither the male nor the female organs were normally developed.

According to "Science" an American Silurian scorpion was found on November 10th, 1882.

The number of Tertiary fossil plants is estimated by L. F. Ward ("American Naturalist") at 5000.

H. Hale ("Science") states that the average stature of the Patagonians, including both sexes, is 5 feet 10 inches. It is further considered that, in the two centuries since they assumed equestrian habits, their legs have decreased in length by 2 inches. So that their former mean stature must have been 6 feet.

Says the "American Naturalist"—"It is a great error to confound criticism on behalf of the truth with personal hostility, yet it is an error by no means rare."

According to the "Deutsche Rundschau," in 1882 two and a half "milliard" copies of newspapers were circulated through the Postal Union. The bulk of this matter being political, it is easy to see that America is not the only country which—in the language of our late contributor Dr. G. M. Beard—is trying the ruinous experiment of making every man, woman, and child an expert in politics.

M. G. Carlet ("Comptes Rendus") has made a re-examination of the structure and the movement of the blades in the sting of the bee. It is not merely a perforating tool, but an aspirating and ejecting syringe, which fills and empties itself at every stroke of the piston.

According to MM. Lépine and P. Aubert, an examination of the poisonous character of urine shows that in the normal excretion the toxicity of the ash forms at least 85 per cent of the total toxicity, whilst in certain febrile urines the toxicity of the ash is only 55 per cent, the residue being due to the organic matter.

Dr. C. S. Minot ("Science") gives a curious instance of a lady who associated the months, or the names of the months, with certain colours: January, February, and March being bright yellow; April, blue; May, a light yellow; June, bright green; July, glaring yellow; August, orange; September, a golden brown; October, dark brown; November and December, grey.

The vacancy among the Trustees of the British Museum, left by the death of Lord Haughton, could not be better filled than by Lord Walsingham,—a far more suitable man.

M. A. Millot has effected a new synthesis of urea by the electrolysis of dilute ammonia, wood-charcoal being used as the positive electrode.

According to MM. Lépine and Roux, as communicated to the French Academy of Sciences, *Micrococcus ureæ*, if introduced into the urinary passages of a healthy animal, occasions cistitis and nephritis.

Prof. E. D. Cope ("American Naturalist") considers that, as far as the future of the human race is concerned, "the only cause for regret is the apparent inability of the best intellect to reproduce itself in any abundance."

Dr. B. W. Richardson, F.R.S., finds a scientific basis for the saying that a cat has nine lives. If a cat and a dog are shut up in the same "lethal chamber," the cat survives on the average three times as long, and in one instance nine times.

Says the "Popular Science Monthly," in an article on "Officialism in Education," "We do mean that in every official system the official or bureaucratic spirit is a constantly growing force, and must tend to a stereotyping of methods, and to a more or less barren uniformity in the minds moulded under its inflnence."

Sen. P. Tacchini ("Comptes Rendus") observed, on the summit of Etna, beneath a pure sky of a very deep blue, the sun surrounded with a white halo, concentric with a coppery red corona. Since July 2nd the phenomena observed in 1883 and 1884, after sunset and before sunrise, have reappeared.

The following is forwarded us by a contributor:—"Dr. William W. Ireland, of Preston Lodge, has in the press a work entitled

'The Blot upon the Brain: Studies in the History of Psychology.' It treats of the hallucinations of Mahomet, Luther, Joan of Arc, Swedenborg, the insanity of the Cæsars and of Ivan the Terrible, and the hereditary neurosis of the royal family of Spain, &c. Messrs. Bell and Bradfute are the publishers.

The progress of sexual evolution in the animal kingdom resolves itself into three main stages,—germiparity, hermaphroditism, and unisexuality.

J. D. Caton ("American Naturalist") has discovered a species of blind fishes in the water of an Artesian well, 170 feet in depth, in California. Artesian wells in the Eastern States have already yielded eighteen species of sightless fishes.

S. N. Rhoads, in the same journal, gives some instances of the tenacity of life of the raccoon. We suspect that if this animal were placed in Dr. B. W. Richardson's asphyxiating chamber it would outlive the cat.

"Cosmos les Mondes," on the faith of German journals not named, gives an account of the electro-magnetic properties of a plant, *Phytolacca electrica*. On breaking a stem the hand receives a shock like that given by the conductor of an induction-coil. At the distance of 6 metres the needle is affected, and becomes quite deranged if brought nearer. This energy reaches its maximum at 2 p.m., and almost disappears at nightfall. No bird or insect ever alights upon the plant!

The general Congress of Geologists was adjourned last year for fear of the cholera. This year the Social Science Congress declines to meet for fear of another disease,—the General Election.

We see, in an exchange, mention of a rain of small tortoises which took place at Raleigh, in North Carolina. These animals, from their flattened form and higher specific gravity, are more rarely carried through the air than frogs or fishes.

The supply of fleas in Paris is said to have greatly fallen off this season, a fact which some persons connect with the possible approach of the cholera.

Professor Chevreul entered upon his hundredth year yesterday (August 31st).

Lake Mono, the "Dead Sea of the West," is situate in the county Mono, in California. This sheet of water, 90 miles long by 18 in width, is so intensely alkaline that nothing can live in it. Its shores are barren and desolate.

The old story of a battle between a spider and a toad, in which the latter when bitten had recourse to plantain leaves as an antidote, has been revived, and is being reproduced with variations. M. Lataste points out that the toothless toad would have some difficulty in chewing the leaves of the plantain, whilst any small animal biting the back of a toad would soon perish from the venom contained in the dorsal pustules.

The Mariano de la Barcena ("American Naturalist"), in describing some fossilised human bones found near the city of Mexico, mentions that the canine teeth are not conical, but have the same shape as the incisors.

The death of the great bureaucratic *savant* H. Milne-Edwards has called forth from his friend M. de Quatrefages an exaggerated eulogium, which contrasts strangely with the scanty laurels which the speaker, three years ago, strewed on the tomb of a far greater naturalist.

MM. P. Brouardel and Paul Loye have studied the poisonous action of hydrogen sulphide. They distinguish two forms,—the one instantaneous, due to the action upon the nerve-centres, and the other slower, showing a combination of cerebral symptoms with those due to asphyxia.

From "Science" we learn that on July 4th the American Board of Control of the Theosophical Society passed a resolution "That the Theosophical Society shall assume and exercise supervision of the American Society for Psychical Research." They further "authorised and required" one of their own number "to act as censor of the said American Society for Psychical Research, and to publicly review and criticise any and all of the Proceedings, Transactions, &c., which the said Society may publish, at his judgment and discretion." They further "expressly require him, when any fact in psychic science shall have been satisfactorily established by the American Society for Psychical Research, to explain such fact to the said American Society, according to the doctrines and upon the principles of psychic science, of which the Theosophical Society is the custodian in the United States."

"Science," in commenting very temperately on this amazing piece of assumption, asks "What body will come forward to 'assume and exercise' supervision of the American Board of Control of the Theosophical Society?"

3 SEP 1885

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THE

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OCTOBER, 1885.

BRITISH MUSEUM

I. THE INTERBOND OF THE SEEN AND THE UNSEEN.

Collated by the AUTHOR OF "SCIENTIFIC MATERIALISM."

The narrative is generally in the words, but always in the sense, of the enunciations of Andrew Jackson Davis, when in his Seer state. These utterances were taken down by Mr. Fishbough as they were delivered, and afterwards published by him in a work called "NATURE'S DIVINE REVELATIONS," *in three parts, viz.,* "*The Principles of Nature,*" "*Nature's Divine Revelations,*" *and* "*A Voice to Mankind.*"

> "There are more things in heaven and earth, Horatio, than are dreamt of in your philosophy."—*Hamlet.*

THE work "Nature's Divine Revelations" was delivered by Mr. Andrew Jackson Davis when in a state of clairvoyance induced by Mesmerism, the manipulator being Dr. Lyon Smith.

Before entering upon the subject of the work given under the peculiar condition termed *Clairvoyance*, it seems wise to give a synopsis of the history of the clairvoyant, by Mr. Fishbough (the reporter of the utterances as they were delivered). The short memoir here given is a digest of a biography appended to the work. Mr. Fishbough, its compiler, procured all evidences attainable by him of the childhood and youth of Mr. Davis up to the period of the delivery of the lectures (as they are termed), evidenced by various letters from various persons who were thoroughly informed upon the subject. Of Mr. Fishbough's capability for the position assigned to him, and of his absolute integrity, there can be no possible doubt. Nor is this all: the lectures were attended by many persons; a list of the most prominent will be found in page 2 of the work. On the manuscripts of one hundred and forty (MSS. Reports) there are two hundred and sixty-seven signatures of persons who had been witnesses of their delivery. Here and there is a lecture which has no signature (seventeen in all), "but the identity of the source of these with that of the others will not be doubted by anyone on proper investigation."

The evidences authenticating the whole proceedings have been most carefully preserved; they are so complete as to leave no room for doubt. The lectures themselves, all circumstances considered, afford the greatest of the evidences.

Mr. Davis's father was a shoemaker in poor circumstances. Neither father nor mother were particularly inclined, if at all, to intellectual pursuits, and the son received, but for a very limited period, such education as could be acquired in a district school, what in England at that period would have been termed the Parish School; in the whole five months, wherein he learned to read imperfectly, to write fairly, and to do simple sums in arithmetic, and had no desire to study, or to improve himself. He is supposed to have been born on August 11th, 1826. In early boyhood he was employed as a cattle-keeper; afterwards, when twelve years old, for eighteen months he worked with his father at his trade: he then was engaged in a grocery store, where he continued until he was fifteen, when he was apprenticed to Mr. Armstrong, with whom he continued two years, who says—"His education barely amounted to a knowledge of reading, writing, and arithmetic. His reading was exceedingly limited, and confined to that of a light and juvenile description. During his two years apprenticeship he established a character for faithfulness and integrity not to be surpassed, and which is seldom equalled." Mr. Bartlet gives a somewhat different account. After A. J. D. had left Mr. Armstrong, he says, he knew him from 1842 to 1845; at an early age he was thrown on his own exertions for support. "At the date of our intimacy no one could resist the conviction that his advantages had not been sufficient to give him common proficiency in the simplest elements of the English language. Decided disadvantages were all around him . . . so far as obtaining an education was concerned; for during my acquaintance with him, which was most intimate from A.D. 1842 to 1845, he had not an hour's schooling, nor could he have afforded it consistently with his circumstances, yet he possessed an enquiring mind,—loved books, especially controversial religious works." "The singular powers claimed for Mr. Davis were brought into public notice by Mr. Wm. Levingston, a tailor, by whom he continued to be mesmerised for eighteen months."

On December 1st, 1843, the first experiment of his clairvoyant state took place under various tests which were quite successful; the result was to establish his power of interior sight beyond dispute.

Mr. Fishbough became acquainted with him in July, 1844, at the time when Mr. Davis, a boy of 18, was thrown into the mesmeric state for the purpose of examining disease. Before him "the human system seemed entirely transparent, and to our utter astonishment he employed the technical terms of Anatomy, Physiology, and *Materia Medica* as familiarly as household words. . . . From infallible indications presented we saw that there could be no collusion or deception, and no such thing as receiving his impressions sympathetically from the mind of his magnetiser."

Mr. Fishbough is entirely of opinion that the work was not the result of sympathetic impulse. There were in all one hundred and fifty-seven lectures; the time of delivery varied from forty minutes to four hours, commencing November 28th, 1845, and concluding January 25th, 1847. Three witnesses, a mesmeriser, and a scribe were chosen by Mr. Davis when in an abnormal state. Other persons also were admitted during the delivery of the lectures, "ranging from one to six, whether they were believers or unbelievers in clairvoyance, and such persons were always instantly distinguished by the lecturer while in his superior state."

For other matter respecting the lectures, or Mr. Davis, reference must be made to Mr. Fishbough's memoir in the commencement of the book.

The work contains 782 pages 8vo., of close print. However peculiar its phraseology and immense its tautology, it professes to be a Philosophy, comprising Cosmology, the peopling the world, advent of man, and his destiny. There is also a complete Biblical commentary. It must be confessed that the reading the work is one of intense and wearisome labour, yet to the curious in such literature the labour is repaid, as it exposes a really grand philosophy. The key-note of the whole is—From *Motion came Matter;* from Life, with the addition of Motion, the Vegetable Kingdom arose;

from Motion and Life, with the addition of Sensation, the Animal Kingdom arose; from Motion, Life, and Sensation, with the addition of Intelligence, the Human Family: thence follows the Soul or spirituality of man. It is difficult to class the views of the lecturer: at one time they are Materialism, pure and absolute; at another time they appear to be wholly Spiritual. The eventual solution is the education of the soul in this world and in that to come, the consummation being Wisdom, Purity, and Truth, and the indwelling with the Divine mind, which is described to be the soul of the Great Positive mind, out of which all things flowed and in which all things are.

All theologies are commented on, and none are accepted, the only realities of the soul being Love, Wisdom, and Truth.*

The whole system is an undoubted philosophy, and one of a high order. There are of course many errors and crudities, and assumptive conceits; despite all the peculiarities, even when dissent is excited, the feeling is, to say the least, one of utter astonishment that such utterances can have proceeded from, in a worldly point of view, an ignorant and uninformed man; for it would tax the knowledge of many well-read men in various branches of Thought and Philosophy, even if the knowledge was combined, to produce the system in comment.

It is my purpose, without the expression of my own opinion, to give not a digest,—that the limits of the Journal would render impossible,—but to notice the general aspects of the work, and if possible to render a true but running account of the first two books, *viz.*, "The Principles of Nature" and "Nature's Divine Revelations." The "Voice to Mankind" is out of my province: those who delight in the most utter Socialism may probably find matter congenial to their minds.

The Key or "Principles of Nature."

"Reason is the principle belonging to man alone; the office of the mind is to investigate, search, and explore the principles of Nature, and trace physical manifestations in their many and varied ramifications. Thought in its proper nature is uncontrolled—unlimited." "Ignorance, Superstition, and Bigotry have wielded a tyrannical sceptre, and

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* "Alas! when will men perceive the difference between religion and priestcraft? When will they perceive that reason, so far from extinguishing religion by its more gaudy light, sheds on it all its lustre?"—BULWER.

Sectarianism has usurped the dominion over the human soul." "Man has lost much of the light and knowledge which he would now possess if the *real* had existed in place of the artificial."

Institutions have been founded on artificial demands, to support which man, against his nature and duty, and at the entire sacrifice of justice, feelings, and conscience, has used the sword against his fellows. War, Persecution, Vice, and Misery have thus reigned; thus the Moral, Social, and Intellectual have been crushed and prostrated, and all the mental slavery forced upon man has been caused by a perversion of his natural inclinations and of the principles of Nature. The hope of ameliorisation must be based on mental progress, when examination of the experience of the errors of the past will serve as a monitor for the future, but in the present there is no liberty for the unrestricted exercise of thought and its expression.

Would it not be well to understand and recognise the law which controls Nature and man with an undeviating and unchangeable government, rather than rely upon the rule of artificial laws? Then the great tree, so long concealed from mental view, whose roots have existed eternally, founded only in that great system of Nature of which man is the subject and effect would grow and progress: its fruits would then be the united interests of mankind: then ignorance, which has been and still appears to be inexorable in its influence, would be destroyed by the annihilating hand of truth and wisdom.

Theories founded on visible facts men have laboured to reduce to Science, believing the fact was attributable to some cause invisible, search was made and the cause demonstrated. Science founded on this ground cannot be overthrown,—*i.e.*, the causes are true and the effects are true. But those who expect effects to manifest themselves to the senses as *unchangeable* would be mistaken as respects their *particulars* and *minutiæ*. There are such things as general causes to produce general effects; but there is not such a thing as a general cause manifesting invariably both *general* and *minute* effects, particularly when these effects are looked for or expected in *forms*.

"Reasoning from effects in a retrograde manner men have arrived at non-entity, and become confirmed in a disbelief of anything beyond what the senses will recognise as existing. Are you not convinced, by the fluctuating nature of things external, fluctuating, and transient, and which are fleeting and evanescent as the leaves of trees, that these are mere *effects*, and not *realities?*—that the *real* or *cause* is *invisible*, and that the effect is a mere transient *expression?* Matter and form cannot be depended upon as producing the same and unchangeable appearances, for there is a perpetual exhalation and inhalation going on throughout all Nature imperceptibly—a steady flux and reflux of matter." The causes of these invisible changes are invisible, "not to be heard or seen, yet nevertheless actual and real." Thus "make the evidence of truth the amount of evidence received *through* the organisation, and not that originating in the organisation." The outward is an instrument, an agent, a medium through which may be tested things external. Thus "the *body* is a *form*, is *transient*, is *changeable*; the *internal* is *not* changeable. The *man* is the *internal;* the *effect* or *form* is *external*. The mind is not acted upon by, but acts on, the body. That which is internal is the reality; that which it acts on is visible and mortal." Tracing effects shows an incalculable amount of causes and effects. Tracing causes to effects and effects to causes is the true mode of reasoning, and this you do in imagination until is arrived at "a chaos of existence: there stop breathless, and return to ask—What was the cause of the *first* cause? You would not have gone on these trackless peregrinations if you had but considered all forms and externals are not *causes*, but *effects*."

The course of reasoning to be pursued will be "to commence at the First Cause, and trace causes to effects until they reach the human body, which is an ultimate effect of the Great Cause," and then inversely. The mode of reasoning will be understood by the following illustration:—Conceive a germ hidden in the Earth; forget its existence, yet in a few years cast your eyes on the spot, it is a tree: "it is as impossible to disbelieve its *existence* as to doubt the germ which produced this existence. The tree stands and is visible as an ultimate; man stands and is also an ultimate. The germ of the tree, you knew of its existence, but the germ of the world you do not know of its existence; but is it not evident that the *latter* is at least possible, since the first is known and demonstrated?"

"All things external in forms, series, and degrees, appear to different persons to present different manifestations." A note by Mr. Fishbough explains "that forms, series, and degrees is the unfolding of the various and successive stages or kingdoms of creation."

"You have a foundation of belief called the evidence of the senses,—*e.g.*, vision. All give their united testimonies that they *see* the sun rising in the east and setting in the west. The unreality of this position is shown in that the Sun, as regards the Earth, does not move. It is the visible and external you are deceived by, and not the invisible, which is the reality." Thought is invisible; the only mode by which the world becomes convinced of its reality is its manifestation in the body. You see light as from fire; if you had not a previous conviction that it would burn, you could only know that it would do so by contact. "This presents evidence . . . that the internal is the *cause* and *reality*, the external the effect."

"It is now clearly seen and proved that the things which constitute *causes* are invisible, and that their *effects* are manifested in all forms external. Hence the latter cannot be *realities*, for such a supposition would involve a self-inconsistency."

Animal Magnetism.

"This science is founded on two fluids, *magnetism* and *electricity*:" then follows a description of the senses, vision, hearing, smelling, feeling. "Each of these senses may and does perform its office indirectly on the mind without any direct interference or connection with anything external." During sleep the system is recruiting itself, but the organs of sense are closed to external impressions; the mind then makes imaginative excursions to different places and contemplates different things in existence; it supposes it sees, hears, walks, tastes, and sometimes suffers excruciating pains; it also appears in many places where it had no previous desire or intention to be. This cannot be *Spirit*, but is *Mind* connected with the body, and its impressions are received through the disturbed condition of the nerves of sensation. "This proves that there is an *internal* medium of sensation by which the mind enjoys its capacity as if the external was in connection with the world."

"Having established the existence of an independent conscious medium, I now explain its existence, its foundation being the muscular and sympathetic nerves." Man has two coatings, the *serous* and *mucous* surfaces. "The *serous* covers each organ, nerve, and fascia of the muscles, including the whole of their surfaces; the *mucous* surfaces constituting the inner of every organ, nerve, and muscle. The serous surfaces and mucous generate and sustain a positive and negative fluid; this controls the circulation.

The negative expands the ventricles, and that attracts the blood to its reservoir. The positive contracts the ventricles, and thus repulses the blood throughout the system. Hence there is a continual expansion and attraction, and contraction and repulsion, which illustrate familiarly the office of these forces. The serous surfaces are susceptible of feeling, whilst the mucous surfaces are not. The muscular nerves are controlled by the mind, whilst the sympathetic, or nerves of sensation, are the medium of actuating the mind when motion produces thought."

"The brain is composed of a sensitive and complicated system of fibres, to which no other part of the body bears any analogy. Being sensitive, it is *attractive* or *positive* to all that is existing on the nervous medium : hence it receives impressions irresistibly. It possesses within itself the positive and negative poles, or greater and lesser parts,—the one controlling, the other subject ; the one receiving power, the other transmitting and exercising power. The ethereal substance which serves as a medium may be termed *magnetism.* The muscular motion of the system is performed through the medium of the substance which may be termed *electricity.** When there is a full and uninterrupted exercise of all the powers and organs of the body,—when there is harmony existing throughout the whole physical system,—there is perfect health and enjoyment, because its forces (which are positive and negative or magnetic and electric) are regularly performing their functions : this indicates a perfect condition of the magnetic or nervous medium." The body on being deranged shows a *loss* of the positive or negative power ; when all are in unison the system is then thoroughly magnetised. In order to *demagnetise* it, this equilibrium must be overcome, and the positive power must be extracted by a power still more positive ; and this will produce the unconscious state called the magnetic.†

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* On this subject Dr. C. B. Radcliffe, M.D., F.R.C.P., has written a learned treatise ("Vital Motion a Mode of Physical Motion") in which he asserts the same position. Dr. Radcliffe's work is a scientific and practical illustration of S. T. Coleridge's idea, that electricity was the method of organised function ("Theory of Life"). West, of Alford, had some such idea, as had also Sir Chas. Bell and others. Humboldt believed in animal electricity.

† Dr. Esdaile, in India, employed mesmerism as an anæsthetic, as also do many physicians in North America. In 1856, at New York Hospital, I witnessed a most successful operation under mesmeric influence. An athletic man had his arm crushed so badly that it had to be removed at the shoulder-joint. The patient was placed under influence, and was carved at the discretion of the operators. I heard no sound, nor did I observe a muscle wince ; I watched narrowly, because I was a disbeliever. The joint was disengaged from the socket, and the skin sewn over the wound. When all was completed the patient was awakened ; he stared around him, but did not

"Magnetism composes the sphere—rather the atmosphere—by which every person is individually surrounded; besides there is a medium which extends through all things placing man over the lower animal creation. All animals are subjected to man's control by the positive or subduing power which he possesses, and they receive this to their minds by the same medium which exists between an organ and the brain. Man being positive. and all else negative, the latter must yield to his control."

When a system is *demagnetised* sensation then only exists upon the internal or mucous surfaces which produce vital action: the negative power only remaining, vital action becomes torpid and feeble, according with the loss of power which previously controlled it. This is the magnetic state; and in this peculiar condition the patient is in sympathy with, or is submissive to, the will or positive magnetic power of the operator. The subject and operator form *one* system in power. There is a visible disunion, yet there exists an invisible union. Thus the phenomenon does not controvert or subvert any of the laws of Nature, but should rather be looked on as a progression and further development of the laws which govern organic beings.

There are *four* magnetic states of magnetism. In the *first* no particular phenomena are witnessed: in this state the person loses none of his senses, but is subject to all external impressions. In the *second* state the patient manifests his intellectual faculties, but is deprived of all muscular power. In the *third* state there is a strong sympathy between the operator and his subject. The chain of sympathy which connects the mind of the operator with that of his subject is *animal electricity*—the fluid which is the agent of all muscular motion, and through which magnetic sleep is induced—this is supposed to be the *clairvoyant* state, but it is not; it stands in analogy to *natural somnambulism*. The first is a phenomenon induced by magnetism; the latter is a similar mental state naturally produced by an inactivity of the magnetic medium, or sensation. In the passage from the *third* to the *fourth* state the mind loses almost all sympathy which attaches it to the system, it being nearly disconnected, and sustains the connection by a very minute and rare medium, the same that connects one thought with

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appear to manifest any sensation of pain. I forget the result. I have an indistinct idea that after a short time the man died, owing to a fever which supervened.

another. In the *fourth* state the mind becomes free from the organisation, except as connected by the medium as above: it is then capable of receiving impressions of foreign or proximate objects, according to the medium with which it becomes particularly associated. The body is at this time dormant and inactive in all its parts, except the negative, or muscular and vital action, which is constantly kept up and controlled by the united forces of the operator and the operatee. This stands in analogy with the state known as death.

"Death is produced by the loss of both forces; but the clairvoyant state is produced by the blending of the forces of the two persons, and making them physically equivalent to one. The mind, in the first case, loses all the medium which connects it with the body; the latter is the same state mentally with the former, with the exception of the mediums referred to." *

"All the phenomena are seen and do exist with every being. Their healthy state is the magnetic state; and the various conditions and development of the mind during sleep, until death, are analogous to the various phenomena induced by magnetism,—only one is an ordinary manifestation, and the other is a further development of the same principles and laws which constitute and govern animal organisation."

"A great question now presents itself for investigation. *Is there such a thing existing as independent clairvoyance?* I answer, There is. You ask for proof; such you shall receive by the following investigations."

The meaning to be applied to the word independent should be well understood. If it is understood as self-existent, abstract, indefinite, and without any connection, then it is nothing, "for in this sense there is no such thing as independent." But if it is understood as meaning "free from direct instigation, then it *has* meaning."

Speaking of himself in the superior state (fourth mesmeric state), he says:—"The medium existing between thought and thought, between mind and mind, between time and eternity, is the only active pervading medium which I am dependent on for the conception of thought, and for the perception of all things of a refined, ethereal, or spiritual constitution. This is whilst the activity of the body and mind appears to be sympathetic or dependent. I am not impulsed or impressed by the thoughts or feelings of a foreign person, though I am cognizant of them through the medium above termed ethereal."

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* Should the reader be interested to trace the above matter respecting the mesmeric states *in extenso*, he will find it set forth from pages 30 to 38, "Principles of Nature," the first part of "Nature's Divine Revelations," and it is surmised that the illustrations, &c., will well repay his industry.

(To be continued).

II. ON CERTAIN ERRORS IN LUNAR OBSERVATIONS HITHERTO UNKNOWN.

By Major-General A. W. DRAYSON, late R.A., F.R.A.S.

BEFORE chronometers had been constructed so as to give an exact measure of time, the Lunar was the best means of obtaining a close approximation to Greenwich mean time, when the observer was in localities distant from Greenwich. It is possible that an accident may happen to a chronometer, and no accurate means other than a Lunar can be made use of to obtain Greenwich time. Observing the eclipses of Jupiter's satellites may give an approximation to Greenwich time; but this is not so accurate a method as the Lunar, unless the observer possess a large telescope, and this telescope is fixed on a stand. No navigator ought to be unacquainted with the method of measuring the altitudes, and lunar distances, and of working out the calculations.

As a problem only, the Lunar is worth studying, as it presents some very neat and beautiful examples in Geometry, and affords an excellent test of the skill of an observer, in measuring altitudes and distances.

I believe I can claim to have measured and calculated more Lunars than most observers, because, during the thirteen years that I had the superintendence of the Woolwich Observatory, I instructed more than one hundred officers and many more cadets on this subject, and during some years I measured and worked out between three and four hundred lunars per year.

Having the means of knowing Greenwich time to a second, I could test the accuracy of my observations by comparing the time found by the Lunar with the time shown by my chronometer. From these comparisons I discovered that, whilst under some conditions I obtained results which were correct to within five seconds of time, under different conditions I obtained results which were twenty seconds or more in error.

Having used the same sextants in each case, and these sextants being in perfect adjustment, I at first supposed that on some nights my eye was better suited for observation than it was on other nights, and that "personal error" was the explanation of erroneous results.

I found, however, that when I had tabulated these errors, there appeared to be a law connected with them, so I set to work to discover, if possible, some other solution of the mystery than that of personal error.

On looking over the article on Lunars, in an early edition of the "Encyclopedia Britannica," I saw it stated that some error existed, but where this error lay was not known. But the more perfect the instrument, and the more accurate the observers, the more certain was the error to be manifested. To search for and find the solution of a paradox is always interesting, and although the Lunar observation and Geometry generally are now out of fashion, whilst vague theories and speculations are popular, I yet trust that some readers may take an interest in a novelty, though this is a geometrical one.

I will first endeavour to explain the principle of the Lunar.

The Moon moves by its own independent motion from west to east round the Earth, its rate of movement being a little more than 13° in the twenty-four hours. If, then, the Moon was coincident with a star at (say) 9 p.m. on a given night, and moved directly away from this star, then on the following night the Moon at 9 p.m. would be slightly more than 13° to the east of this star. The star being fixed, whilst the Moon moves, causes the Moon to act like the hand of a clock, whilst the star remains fixed like a mark on a disc.

By measuring and calculating the exact distance of the Moon, from the Sun or from certain stars, we are provided with one item; the other item being—knowing what the exact distance of the Moon is from the Sun, or star, at certain instants of Greenwich time.

Now the distance of the Moon from the Sun, or from certain stars, is given in the "Nautical Almanac," for intervals of three hours for every day of the year; consequently we can compare our measured distance with the calculated distance given in the "Nautical Almanac," and by proportion find what the Greenwich time was when we measured and found our lunar distance.

The practical method of making the observations is as follows:—

1st. When three observers can be obtained, one observer measures the altitude of the Moon; another, the altitude of the Sun, or a star; the third measures the angular distance between the Sun and the Moon, or between a star and the Moon.

2nd. When one observer only is available, he measures first the altitude of the body which changes its altitude more slowly, then the altitude of the other body, then the lunar distance, then the altitude of the body moving most quickly, lastly the altitude of the body moving most slowly. The times at which each altitude is taken, and the time at which the lunar distance is measured, and the change in altitude of the two bodies, can then be reduced to the time at which the lunar distance is mentioned, so that the same results are obtained by one observer as could be obtained by three, *viz.*, the exact altitudes of the Moon and star at the instant at which the lunar distance was measured.

The problem now before us is to obtain the exact distance of the Moon from the Sun or a star. The measured distance is not the true distance, because the star, in consequence of refraction, appears higher in the heavens than it is in reality. The Moon from the same cause appears higher, but the Moon in consequence of parallax appears lower than she is —consequently a correction is required to be made to the Moon's measured altitudes for refraction and parallax, the first being a minus, the second a plus correction.

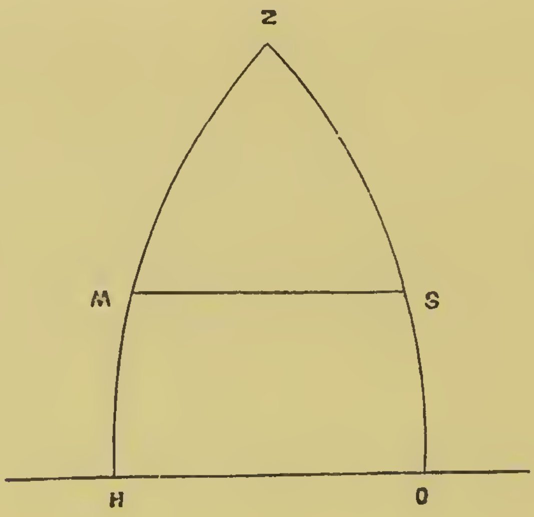
There are several formulæ for working out a Lunar, and obtaining the true lunar distance from the measured lunar and altitudes; but I always found that students understood the problem better if I treated it as a pure matter of spherical trigonometry,—consequently I adopted in instruction the following method:—

Having obtained the altitude of the Moon and star, as mentioned, and the lunar distance, do not correct for parallax or refraction, but find the angle with the Zenith, formed by the Moon and Star, as follows:—*viz.*, H M the altitude of the Moon as measured, consequently *Z* M the Zenith distance of the Moon.

O S the measured altitude of the Star, consequently *Z* S the apparent Zenith distance of the Star. M S the angular measured distance between the Star and the centre of the Moon.

We have three sides—*viz.*, *Z* M, *Z* S, and M S—to find the angle at *Z*.

Having found the angle at *Z*, correct the Zenith distance *Z* M for parallax and refraction, and the side *Z* S for refraction.



Both parallax and refraction will be manifested in the direction of the vertical lines *Z* M and *Z* S, and will not therefore affect the angle at *Z*.

Then with the two sides *Z* M and *Z* S *corrected*, and the included angle at *Z*, find the value of the third side, which will be greater or less than M S, according to the position of the Moon and Star, and the third side, so found, will be the true distance of the Moon from the Star at the instant of observation.

By comparing the true distance thus found with the distance given in the "Nautical Almanac" for a certain time, we obtain the Greenwich mean time of the observation.

I have always found this method of teaching Lunars more readily understood than if I employed a sort of blind formula,—such, for example, as the following:—

M the apparent } altitudes of the Moon.
m the true }

S the apparent } altitude of the Sun or Star.
s the true }

D the measured distance.

Make $b = \frac{1}{2}\,(D + M + S)$.

$$\text{Sin } a = \frac{\left\{\text{Cos } b + \cos\,(b = D)\;\dfrac{\text{Cos } m\ \cos s}{\text{Cos M}\ \cos \text{S}}\right\}^{\frac{1}{2}}}{\text{Cos } \frac{1}{2}\;\{m + s)}$$

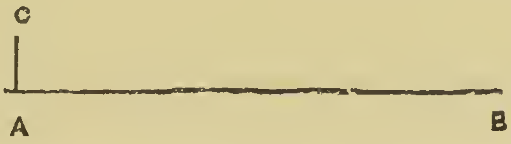
$$\text{Sin } \tfrac{1}{2}\,x = \text{Cos } \tfrac{1}{2}\;\{m + s\}\ \cos a.$$

x = true lunar distance.

We have now gone as far as what we may term the conventional Lunar, and yet there is an error which becomes apparent, when the most accurate instruments and observers have been employed. I will now point out where this error is.

The lunar distances given in the "Nautical Almanac" are calculated from the Right Ascension and Declination of the Moon and Star into each three hours of Greenwich mean time. These distances are the actual true distances of these bodies measured on the sphere of the heavens. The declination of either body enables the polar distances to be obtained, and the difference of right ascension gives the angle at the Pole. Consequently, with two sides and the included angle, the third side can be calculated. The error therefore is not to be found in this department, but in one of a far more delicate kind. In order to point out where the error exists, I must refer to the sextant itself.

When measuring angles between any two bodies with the sextant, the body which is looked at through the object-glass of the sextant becomes for the time being the pole of a sphere. If I set my sextant to any given angle, say 25°, and direct my sight through the object-glass to any particular star, I shall, as I turn my sextant round, cause each object 25° from this star to successively come in contact with the star, and all lines drawn from these objects to the star will be straight lines.



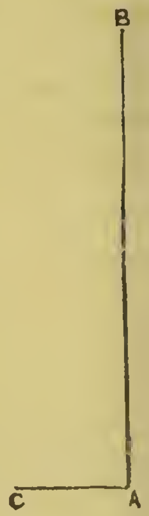
If I take two points on the horizon as follows, *viz.* A and B, 25° apart, and a third point (C) a few degrees vertically above A, the angular distance, B C, measured with the sextant will be greater than B A measured with the sextant, because with B as a centre, and radius B A, the arc would pass on the B side of C.

Every surveyor who has used the sextant knows that if he measures a series of angles round the horizon, and adds together these angles, their sum will amount to more than 360° if the various objects are not on the same level, as shown by C and B. This is due to the fact that C B is the hypothenuse of a right-angled triangle, the right angle being at A. Consequently B C measured with the sextant is greater than C A measured with the sextant.

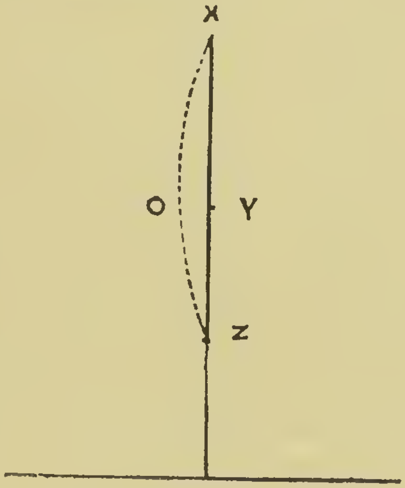
Suppose we keep the three points C A B in exactly the same relative position as regards each other, but take the points A and B as each 30° above the horizon, whilst C is a few degrees vertically above A, and A and C both on the meridian. We have the same apparent conditions as before: C A B appears as a right angle, and the side C B represents the hypothenuse. Consequently, if we measure B C with the sextant, we should find this arc greater than A B; the fact of having elevated this triangle above the horizon, causing apparently no difference in the angular distance as measured with the sextant.

Now let us examine the contradiction which exists. Suppose A and B each 30° above the horizon, whilst C is on the meridian and a few degrees above A. The points C and B may, under these conditions, be both on the Equinoctial, whilst A is a point on the sphere, on the same meridian as C, and is south of the Equinoctial. It follows therefore that, calculated on the sphere of the heavens, the angle at C is the right angle, whilst the angle at A is less than a right angle. Consequently B A is the hypothenuse of the right-angled spherical triangle A C B, and not B A.

By looking through the object-glass of the sextant at B, we make B the pole of our sphere; and the straight line joining B and A, as measured with the sextant, is measured in the same manner as we should measure on a meridian, as shown below. Suppose B A a portion of the meridian, and B the pole, B A C a right angle; the angular distance B C, measured with the sextant, would be greater than B A, and if we turned this triangle down so that B A coincided with the horizon, or so that B A was parallel to the horizon, the conditions as regards measurements with the sextant would not be altered.

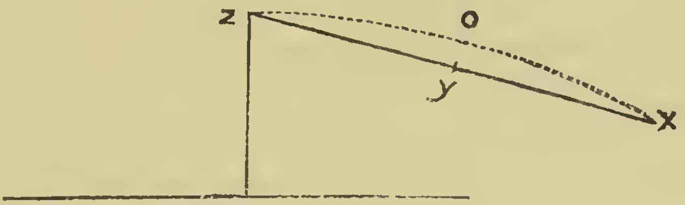


Again, suppose we have three stars vertically above one another, as shown in the following diagram,—*viz.*, x, y, z,—and these three stars are located on the meridian, the angular distance xy measured with the sextant, plus the angular distance yz measured with the sextant, will be equal to xz measured with the sextant.



Take o, a point about 2° to the left of y, the points xoz are not in a straight line, and the angular distance xo, plus the angular distance oz, measured with the sextant, will be greater than the angular distance xz measured with the sextant, two sides of the triangle being greater than the third.

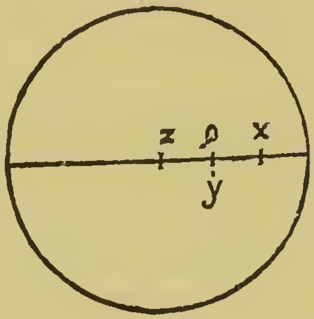
Now, as regards sextant measurements, these results would be the same, no matter how we moved these points, so long as they retained their exact relative position. Consequently we will keep the point z fixed, and rotate the other points round z, when they may be shown as seen below. As before, $zy+yx=zx$, $zo+ox$ will be greater than zx. Consequently ox must be greater than yx, and zo greater than zy, when measured with the sextant.



The point z is on the meridian, and the apparently curved line zox represents the apparent curve of the Equinoctial;

but this curve is *on the sphere* a straight line, and if we represented these four points on the sphere they would be shown as in the diagram below.

The angular distance *z y* calculated on the sphere, plus the angular distance *y x* calculated on the sphere, will be greater than the arc of the Equinoctial *z x*.



Angular distances therefore measured with the sextant on the sphere of the heavens do not, in all cases, correspond to the angular distances calculated on the sphere, and which distances are obtained by the polar distances and difference in right ascension of two bodies.

The true angular distance of the Moon from a star, as given in the "Nautical Almanac," is calculated from the Polar distance of these two bodies, and their difference in right ascension. The measurements taken with the sextant, however, measures as we may term it *straight* between these two objects, and in some instances will give a less distance than that obtained by calculation.

Any person may test this problem by aid of a pair of compasses and a common globe, in the following manner:—Suppose you wished to travel from lat. 51°, long. 0°, to lat. 51°, long. 60° W.

Take a pair of compasses and measure along a parallel of latitude, on the Globe, a distance of 30° of longitude. Double this distance, and the point will be reached which has a longitude of 60° on the same parallel. Then measure the same half distances north of the middle distance, and with the compasses we shall reach a point west of 60° longitude, and on the same parallel. It is in fact the old story of great circle-sailing repeated.

When we measure angles with the sextant between two objects, we make the object we look at through the horizon glass the pole of our sphere, and a *straight* line from this pole to the second object is the angular distance measured.

The arc of the Equinoctial does not appear as a straight line when seen from middle latitudes, but as a curve. Hence measurements between two objects, when taken with the sextant, do not under all conditions agree with angular distances calculated in the sphere.

As I usually selected for the Lunar a time when the Moon or star was near the Meridian, so that its change of altitude in a given time was very slight, I found the error in the results which I have named, and the cause I have now described.

In the "Journal of Science" for July, 1874, and for January, 1875, I described certain facts relative to straight lines on the sphere appearing as curves to individuals on Earth. These facts, however, did not seem to be comprehended at the time, as most puerile criticism and arguments were urged against the facts, or attempted as explanations. The cause hitherto considered inexplicable is due to the same cause which I then described, and accounts for the errors in Lunars which every observer must have found do occur.

The problem, as a problem only, is interesting; but as it is a geometrical question, and Geometry is now too often ignored, and vague theories substituted for it, the Lunar observation may not be so well understood or as much practised as it was in former times.

III. MADMEN AND MADNESS AT ROME.

INSANITY forces itself upon public attention under several points of view. Its treatment, of course, belongs exclusively to the medical profession. So does its recognition, with a view to the restraint of these unfortunates, —a question which is for the present in a most unsatisfactory position. But the late serious increase of mental derangement, and the causes to which this increase is due, concern not only physicians and sanitary reformers but the entire public, and especially all persons who in any manner come forward as the guides and the teachers of their fellows.

The journalist, the preacher, and the statesman cannot afford to neglect a phenomenon so menacing. For, in spite of all the advantages which we enjoy as compared with our forefathers some centuries ago, insanity is increasing among us and among all so-called civilised nations.

In seeking for the cause of this alarming change for the worse the inductive logic bids us fix our attention upon those social factors which have been notably intensified during the last century or half century. Such factors are not few nor trifling, as a comparison between the years 1785 or even 1835 and the present 1885 will at once show. But upon which of these must the blame chiefly rest? In considering these questions it may be not uninteresting to examine the report published not long ago by Dr. Fiordispini, Director of the Manicomio,—the great asylum of Rome. This research comprises the seven years from 1874 to 1880. He insists at the outset that insanity is a disease which from day to day demands more numerous victims. It was once proposed to Pius IX. to build new barracks in order to keep down the Roman populace. The Pope replied in words, the truth of which becomes daily more striking:—"The Romans do not need new barracks, but a new lunatic asylum." Dr. Fiordispini adds that if things continue as at present it will not require a prophet to foretell that a new Manicomio will soon become necessary.

According to the official statistics of 1880, in the three years from 1877 to 1880 the number of the insane increased in Liguria by 23·15 per cent, in Umbria by 24·12 per cent, in Venice by 28·73, in Sicily by 43·88, and in Rome by 32·71. If we take into account the increase of population introduced into Rome by its being made the capital of united Italy we find that whilst there were in 1874 out of every 10,000 inhabitants 2·06 insane persons, and in 1877 3·35, in 1880, from the cessation of certain temporary causes, the proportion has fallen to 3·11.

What are the causes of an increase of which modern civilisation cannot be very proud, and which are certainly a grave set-off against whatever benefits there may have accrued to the Italian nation from its unity and its "redemption?" Dr. Fiordispini distinguishes firstly the general causes, common more or less to all Europe, and the local causes, peculiar to Rome, or at least to Italy.

As regards the former, he denounces what Bossuet calls the tendencies and the spirit of the age. He points to the demand for unchecked liberty in everything and for all, without distinction of age, sex, or condition; to the feverish desire for the riches necessary for the gratification of new wants; the thirst for pleasure which has taken possession of the whole of society, directing its aspirations, stimulating its appetites, and causing it to subordinate everything to immediate material enjoyment. Now this positivism, this naturalism of life, this over-excitement of all the instincts, this "superheated" existence, can but lead to madness and suicide.

It will be of course remembered that suicide is increasing in the modern world no less decidedly than insanity. But leaving this fact on one side we may turn to the words "this positivism, this naturalism of life." Here, surely, are two words not well applied. Modern life seems to us to have at any rate a most decided tendency to unnaturalism, if such a word may be used. But this also is not our present subject.

To these general causes must be added others more or less peculiar to Rome, and here we follow verbally Dr. Fiordispini:—

"The Roman people passed suddenly in 1870, and without any gradual stages of transition, from the practice of confession to liberty of conscience; from the exposition of the Gospel and from Lent sermons to free conferences and public meetings; from religious marriages to civil unions; from clandestine prostitution to public, authorised prostitution; from a theatre subject to censorship to a theatre without rule or restraint; from family life to public life; from the aristocratic distinction of classes to their medley and confusion; from instruction directed by the Church to an instruction recognising no orders; from the exclusion of public affairs to the election of representatives; from a Pope-king to a constitutional government; and we shall easily comprehend how violent must have been the shock to the population and what disturbances must have been introduced both in the physical and the moral order."

It is of course not our province to decide which of these changes is for the better and which for the worse. But we cannot deny the extent and the abruptness of the alteration.

Rome does not in this respect represent an isolated fact. It is well known in France that the times of revolution are those which yield the heaviest contingent to the mad-houses. Buenos Ayres has furnished a sad instance of the same fact during the dictatorship of the notorious Rosas, and the recent events during the supremacy of the Commune at Paris are far from admitting of a contrary interpretation.

From the tables given at the conclusion of Dr. Fiordispini's work it appears that at Rome for every 100 insane men there are only 58 insane women. The reason of this difference is that at Rome, thanks to the education which they receive, the women observe greater discretion, and especially avoid that alcoholism which is one of the principal causes of madness.

Dr. Fiordispini gives a table of the proportion of insanity in different nations. From this we learn that Italy as a whole is still in a better position than England. We have 1 insane person to 514; Italy has only 1 in 1000. But in a table given in 1857 in the "Alliance Prize Esssay," by Dr. F. R. Lees, the proportion of lunatics in Italy is given as only 1 in 3785. Consequently since that date (or from a somewhat earlier one, since the statistics given by Dr. Lees may have been collected a few years earlier) insanity has increased in nearly a four-fold ratio. Our position has also retrograded but in a less proportion, since in 1857 we had 1 insane subject in every 713 persons.

There is one point alike in the tables of Dr. Lees and in those of Dr. Fiordispini which is perplexing. According to the latter authority Belgium has the smallest proportion of insane persons of all the countries which he mentions, namely 1 in 1014. Dr. Lees gives the proportion as 1 in 1046. Now the circumstances prevalent in Belgium are those which are generally considered favourable to mental derangement Its consumption of alcohol per head is equal to that of England; its sexual immorality has been of late years painfully forced upon our notice. It has contested elections and even riots between Catholics and "Liberals," and lastly it is steeped to the very lips in commercialism, greed, and competition. Yet with all these circumstances it has a smaller proportion of deranged persons than any nation in Europe if we except Spain. This is a riddle to which we invite attention.

Returning to Dr. Fiordispini's report:—He classifies the causes of insanity as organic or physical, and as moral, the former being by far the more powerful.

In the first place he ranks alcoholism. The number of persons who have drowned their reason in wine (used here as a generic term), according to an expression too cruelly true, has been increased more than three-fold since 1873, and it is to be believed that it will go on augmenting. Not merely Rome but all other countries present an analogous increase of alcoholism. Up to 1870 Rome had lagged in the rear of the *civilising movement* of what is commonly known as progress.

Under the Government of the Popes there were certainly drunkards, but these were protected against excess by prohibitive laws which touched the vendor, and restrained the facility for intoxication. The Roman, further drank no spirits, and the wines supplied to him cost the producer so little that adulteration was scarcely worth the trouble. To-day the sales of intoxicating liquors increase in a frightful proportion; the wine is sophisticated and is consequently the worse for health. But the most deplorable fact is that the people intoxicate themselves with spirits, the consequences of which are far more disastrous for the human economy. Dr. Fiordispini, taking his stand on the facility which the Roman people now possess for indulging their desire for intoxication, thinks that Rome will be soon in this respect on a level with the other capitals of Europe.

We are compelled here to draw a little closer attention to the change which has lately taken place in the quality of alcoholic drinks. The consumption of wines has decreased, while that of malt-liquors and spirits has increased. The distilled liquors of the day are no longer obtained solely from fruits, from cane-sugar (we do not apply this honourable name to betose), nor even from grain, but to a large extent from roots, and are rich in amyl compounds, commonly known as fusel. Now amylic alcohol has a far more deleterious action upon the brain than has ethylic alcohol. The introduction of the liqueur *absinthe*, now so widely used, has had a very alarming effect. It is to be deplored that our temperance reformers and our sanitarians never seem to seek for a total prohibition of the manufacture or sale of this poison in England, or its importation from abroad.

As regards wines they have long been fortified for the benefit of persons who judge a wine by its intoxicating power rather than by its flavour and aroma. But now the fortification is effected with potato-spirit rich in fusel, and there are even wines which contain not a drop of the juice of the grape. We need therefore scarcely wonder if the use of such wines brings on results which were formerly unknown in the wine-growing districts of Europe. The phylloxera has been a great demoralising agent.

The next physical cause of insanity is heredity, one of those whose effects are least open to discussion. Trelat pronounces it the *causa causarum* of madness. Sad that our law makers who strain at such a gnat as the marriage of a man with the sister of his deceased wife bolt such an albufaki camel as the intermarriage of persons belonging to families tainted with insanity. How much wiser were the laws of the ancient Buddhists? The next cause is a generally dissipated life, the effects of which, however, are not easy to estimate, since it almost invariably includes alcoholism.

Curiously enough we find no remarks on the influence of consanguineous marriages as a physical factor in the production of insanity. Perhaps, however, the wise old law of the Catholic Church which denounced such marriages as incestuous is still observed in Italy, and thus Dr. Fiordispini may have had little opportunity of studying this part of the question.

According to many physicians moral causes alone can never engender insanity, and where it appears either heredity or some other physical cause must have been at work. Mantegazza even said that with a well constituted brain a man can never become insane.

The question arises, however, in how far moral causes acting upon the parent may be translated into physical causes—*i.e.*, defective or otherwise morbid structure of the brain—in the child or the grandchild?

Among the moral causes which Dr. Fiordispini discusses is contagion or imitation. It is impossible, he holds, to witness for any length of time the spectacle of the intellectual aberrations, the delirium, and the extravagant convulsions of the insane without undergoing a painful and a more or less durable impression upon the mind. This is an effect analogous to that produced by reading sensational novels, accounts in detail of the deeds and the trials of criminals, or by witnessing a certain class of dramatic performances. The readers or hearers of such productions are led by degrees to repeat actions identical with or analogous to those the impression of which is deeply engraven on their minds. At the Manicomio at Rome among a staff of 327 persons engaged in watching and attending to the insane, 3·98 per cent have been attacked with the same affection. This proportion is serious, as it amounts practically to 1 case of mental disease out of every 25 of these persons, whilst the proportion of the insane among the entire population of Rome is only 1 in 585. Hence in Rome the keepers and nurses in a lunatic asylum are 23 times more liable to become insane than are their fellow citizens, other things being of course equal!

We may here refer to Dr. Rambosson's interesting researches on the transmission of moral phenomena by contagion, and to the opinion expressed by Dr. B. W. Richardson that the insane exhale an essence of madness which may infect other persons by whom it is inhaled.

The action of competition and overpressure as most effectual moral causes of insanity, as well as of other diseases, is indisputable. But what of that? Whilst touching on this subject we feel bound to borrow the following just remarks from the " Medical Press and Circular." Says our contemporary :—

" It is not often that an ostensibly respectable journal has to sup humiliation, publicly and copiously, as the "Spectator" had to do on Saturday last, when it was compelled to publish a letter from Dr. Crichton-Browne convicting it of having knowingly said what was directly untrue in a review of a Danish work on Overpressure. The attitude which the " Spectator " has adopted and maintained towards the medical profession throughout the overpressure controversy has not in any degree surprised us, for it might have been expected that a journal that gushes over the twitchings of a decapitated frog would be deaf to the cries of suffering children; but the discreditable position into which its rancour has betrayed it does certainly awaken wonder as well as commiseration. It was scarcely to have been anticipated that a highly superior journal that is for ever congratulating itself that it is not as other journals are should have been caught fibbing flagrantly, and has been ignominiously punished on the spot. Yet such is unhappily the case; and so audacious is the untruth that has been brought home to our contemporary that it is almost impossible to avoid the conclusion that this is not its first offence. Presuming, we suppose, on the indisposition of authors to meddle with their critics, even when they are very far wrong, it repeated the misrepresentation which was put in circulation last year, and was then contradicted, that Dr. Crichton-Browne's report on 'Overpressure in Schools,' was an officious and spontaneous production which was violently thrust upon the mild and unsuspecting Mundella, very much against his will. But it miscalculated the endurance of Dr. Crichton-Browne, who has promptly turned upon it and compelled it to eat its leek with what grace it could muster. With an extract from 'Hansard' containing Mr. Mundella's intimation to the House of Commons that he had invited Dr. Crichton-Browne to report to him, held up before it, it admits that it was 'mistaken.' But this is not a question of mistake, but of mendacity, for the accusation is that the reviewer made his untrue statement knowing the real facts, and no one can question that the charge has been fully proved. Our contemporary is abject, but we fear unreformed, for in its note to Dr. Crichton-Browne's scathing letter, it performs a wriggling movement which might be called mendacious. Endeavouring to show that if it was wrong on one point, it was right on another, it argues that the report referred to was really unchecked, because Mr. Fitch's little memorandum was not written until after it was finished, thus ignoring the fact mentioned in Dr. Crichton-Browne's letter that Mr. Fitch accompanied him on some of his visits to schools, and had opportunities of checking his observations while they were being made."

IV. SANITARY AGENCY OF LIGHT: INFLUENCE OF THE SUN UPON THE VITALITY OF MICROCOCCI.

THAT light is essential to a vigorous state of health has long been admitted; but that the sun is a "sanitary" agent in the narrower sense of the term, a powerful ally in our war against so-called zymotic diseases, is not fully known: at least it has not yet met with practical recognition.

M. E. Duclaux, some little time ago, laid before the French Academy of Sciences a series of observations on the influence of sunlight upon disease-bacilli. He has now extended his researches to micrococci. Of these minute beings he has specially examined six kinds, including those of *Pemphigus*, of *Impetigo contagiosa*, one found in the blood and urine of a patient suffering from rheumatic nodosities, &c. All these micrococci show a considerable resemblance both morphological and physiological, but they are nevertheless specifically different.

The action of the sun upon them differs accordingly as it is exerted upon an individual more or less mature, and whether it has been preserved in the dry state or in a culture-fluid. It varies, also, according to the season of the year. As regards this last factor M. Duclaux has not sought to eliminate the action of solar heat from the influence of light. This may, from one point of view, be regarded as a defect in his observations. But he—in our opinion very judiciously—thought it well to remain in the normal conditions to which microbic germs are exposed when suspended in the air or deposited on the surfaces of various bodies. It is to be hoped, nevertheless, that a second series of researches may soon follow, to ascertain the influence upon these beings of light alone, as distinguished from heat. The only condition which has been observed as regards heat was not to exceed the temperatures which have been found most suitable for their cultivation, and which lie between 86° and 104° F. The temperature in the sun sometimes rose much higher. The limits of vitality which M. Duclaux found in his experiments are therefore maximum limits, and are so especially under the influence of the solar light.

The results may be briefly summarised as follows:—Young cultures of the micrococci in neutralised veal broth, which live on an average more than a year if kept in the dark or in diffused light, only resisted this year the feeble and intermittent sunshine of the spring for forty days,—that is, from May 4th to June 13th. In July fifteen days of exposure were sufficient to kill them, and a shorter time sufficed to attenuate them and to deprive them of all action upon the organism even of those animals which are most susceptible to their influence.

The vitality is still feebler if a micrococcus is preserved in the dry state, in the imperceptible coating which is left by a drop of culture liquid evaporated on the bottom of a flask. The micrococcus of the "Biskratt boil" and that of *Pemphigus*, which were found still living after being kept for five to six months in this dry condition in the dark, have been killed by eight days' exposure to the sun, from May 26th to June 3rd. In July two to three days were sufficient, and it was about the same for other species. None of those which M. Duclaux studied resisted three days of insolation, from July 7th to 9th, at a window facing the south, but which received the sun only for four hours daily, from 9 a.m. to 1 p.m., and where the temperature never exceeded 102° F.

These are lower figures than those which the same biologist has previously found for bacilli. The difference probably turns on the fact that in the micrococci the most resistant state of these beings, if it exists at all, is rare and still unknown.

But however this may be, it is interesting to establish the fact that a few hours of exposure to the sun suffice first to attenuate and finally to kill these micrococci, which include so many formidable and widely distributed species. It thus becomes intelligible why the air carries along so many dead germs; why many diseases, in spite of winds and atmospheric currents, remain confined in their places of origin, and that, when coming from afar, aërial germs reach us in an attenuated condition.

To retain their virulence they require to be conveyed in bales of merchandise, in clothing packed up, or in the dark and moist holds of ships.

In fine, M. Duclaux pronounces solar light the most universal, the most economical, and the most efficient agent which we can employ, either in private or public sanitation.

We may be permitted to point out certain practical applications of the truths which experiment has thus brought to light.

It is generally admitted by official, or would-be official, sanitarians that one of the greatest evils of polluted waters is that they serve as a nursery for the propagation of disease-germs, and as an organised service for their distribution. Surely, therefore, it is exceedingly important that the light of the sun should penetrate, without let or hindrance, to and into such waters. But so long as any water is rendered turbid by suspended matters, or deeply coloured by waste waters from tanneries, dye-works, &c., the germ-destroying action of the sun upon such waters is much enfeebled or altogether annulled.

We have therefore to ask, what is the meaning of the sneer that "clarification is not purification"? Be it so; but if clarification permits the sun's rays to penetrate into waters where they were previously shut out by the opacity of suspended filth, clarification is a step—and no unimportant step—towards purification.

Again, we have heard municipal authorities contend that the removal of, or the exclusion of, colouring matters from a river is of no consequence. "So long as we are free from stench," they argue, "the colour of the river is of no consequence." We now see that it is of great consequence, not merely from an æsthetic or sentimental, but from a practical and sanitary point of view.

This is a consideration which tells heavily against precipitation processes in which lime plays an important part. We know a town containing extensive tanneries and dye-works. We know that its sewage can be readily decolourised by salts of alumina, whilst if treated with lime-water or cream of lime it takes an intense mahogany colour, admirably adapted to hinder the sun's rays from penetrating.

Surely we may say that without clarification and decolourisation there can be no thorough purification!

But we have now to call to mind the fact that certain systems of sewage treatment—systems which have been loudly vaunted, and which it has even been sought to force upon the nation to the exclusion of all others—actually withdraw the sewage and waste waters from the action of light. Take, for instance, "broad irrigation." The sewage, conveyed from the town down to the irrigation farm, rapidly finds its way into the earth, where it is protected from the sun. We may grant that the lifeless organic matter, present in the sewage in suspension or solution, will be to a great extent oxidised or burnt up. But there is no evidence that this fate awaits the living micro-organisms of the sewage. On the contrary, there is positive evidence—as in the celebrated Swiss case—that they may and do emerge from the earth without being attenuated. Further, in a well-arranged precipitation system, the water—rendered transparent by the removal of colouring-matter and suspended impurities—is exposed for some time to the light in the precipitation-tanks, and after that it is often conveyed in open shallow channels for some distance, having the fullest opportunity of insolation.

It is, perhaps, rather a misfortune that other considerations compel us to convey sewage from the places of its production in covered channels, and thus seclude it from the beneficent action of light.

There are quite other spheres where the ignorance of the present day wilfully excludes the sun. Suppose the very common case of a family dwelling in London, or in any other of our large towns, and going off in August to the sea-side for a fortnight, or perhaps for a longer time. One of their most pressing cares on setting off is to close every shutter and blind in the entire house from basement to attic. That this step should be taken with windows accessible from the street is not to be wondered at, but why rooms on the second floor and the attics should thus be consigned to darkness for such a lapse of time it is hard to understand. Perhaps to leave any opening for the light to enter would be a social sin for which Mrs. Grundy has in reserve heavy penalties. We lift up our eyes, and, looking from our library window across two series of suburban gardens, in which

> "Life dies, death lives, and Nature breeds
> Perverse all monstrous, all detested things,"

we see the back of a house which has thus been closed for a month. The inhabitants have even fitted their little conservatory with blinds, striped pink and white, and the unhappy plants are all this time enjoying the luxuries of etiolation. Now when these good people return home, will not the air of a house which has been been kept so long without ventilation and insolation more than counterbalance any benefit which they may have received from the sea-breezes and the problematical ozone of Bournemouth or Torquay? We know an instunce where a family, on thus returning to their shut-up dwelling, were attacked with what was called a "low fever," which, they maintained, had been caught at the watering-place where they had sojourned. To convince them of the truth was impossible.

V. PHYSIOLOGY AND ITS OPPONENTS.*

SCIENTIFIC research, and even the study of science altogether, have been opposed and prescribed at different times under varied pretexts. At one time they were condemned as impious, at another as ungentlemanly in comparison with "classics," and now one at least of the main branches of biological science is branded as cruelty, with all the most ignominious epithets which the heated imagination of neuropaths or the rancour of professional agitators can supply. Some persons may indeed plead that the wrath of the Bestiarians or Humanasters is directed not against physiology in itself but against experiments upon living animals. We reply in the words of Shakspeare:—

> "You take my life
> When you do take the means whereby I live."

In like manner you paralyse a science if you rob it of any of the means of research, of which experiment, the systematic cross-examination of Nature, is, wherever practicable, the most important.

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* Apologia or explanation of my last Article on Vivisection which appeared in a London Journal, September, 1, 1884. By a "WEAK WOMAN" who withholds her name.

The Ethics of Vivisection. By J. ROBERTSON. From "Our Corner." August 1, 1885.

We feel it almost our duty to apologise to Mr. Robertson for having bracketted his thoughtful and acute essay along with the hysterical outbreak of the anonymous "Weak Woman." Both, however, like many other writers on either side of the question, commit one oversight. They seem to conceive of physiological experimentation as a purely *medical* question, the results of which are or ought to be directly applicable to medicine, or to veterinary practice. This error renders it possible to raise the question whether any particular improvement in medical or in surgical treatment is due to such experiments? But what would, for instance, be the position of chemistry or of physics if every train of research had to be justified on account of its direct, immediate utility in medicine or even in the arts? It is now everywhere conceded that progress in the arts requires not merely a narrow knowledge of some few substances and their reactions, but a general abstract knowledge of the whole sphere of phenomena concerned. It has been seen that theoretical, speculative researches on the derivatives of coal-tar have led to a new and a lucrative industry. Behind medical practice stand chemistry and physics developed without any direct reference to the art of healing. Why, then, should the case be other with physiology? Just as the physician regulates his practice by an insight into the chemical constitution and behaviour of the various substances which form the human body, and of the foods, drugs, poisons, and disease germs which are intentionally or accidentally introduced into it, so, and even in a higher degree, he requires a general knowledge of animal life, as accurate and as profound as can be attained, and for this purpose physiological experimentation is necessary.

Mr. Robertson notes that the Bestiarians "strongly con tend that physiological experiment is morally indefensible even if serviceable." The steps in the controversy he considers as few and simple. The Bestiarian alleges that man has "no right" to give animals pain with the view of escaping it himself, or as it would be more properly put in pursuit of knowledge not otherwise attainable. The physiologist "alleging that the right does exist puts it on all fours with the right to use animals for food or to make them work. The Bestiarian replies that, granted the right to kill for food and to put to service, the right to give pain does not follow. And here sets in the dead lock." Now with all respect for Mr. Robertson we can see here no dead lock at all, the last contention of the Bestiarian being in our judgment unmitigated nonsense. We cannot drive animals to market, thence to the slaughter-house and then put them to death with the pole-axe or the knife without giving them pain. We cannot deprive animals of their natural freedom, castrate the major portion of them (a decided piece of vivisection, as Mr. Robertson points out), and force them to work all their lives under penalty of the whip without giving them pain. If, therefore, we have the right to kill and to compel to work we have the right to give pain. And it is undeniable that the pain inflicted in these two ways, could it be arithmetically summed up, would be found incomparably greater than that which has been and is being inflicted in all the physiological laboratories of the world. Those who believe the sensational *historiettes* about "carving to death in cold blood" should recollect that even putting fish into pure water, or into water of any particular degree of hardness with the view of stuying the result is a "painful experiment" within the meaning of the infamous Vivisection Act, and can in Britain be performed only under license!

Mr. Robertson enters upon an enquiry into "rights." He says that the Bestiarian "does not deny the right to put animals to service; and as a rule he concedes the right to kill for food. Now either of these cases will suffice to show that the 'right' of man over animals is simply the assertion of his power. It is occasionally argued, indeed, that where man feeds and cares for an animal his right to its service is one of *quid pro quo*; but it is only necessary to turn to the case of human slavery to find that 'right' in this connexion has no recognition in contemporary morals. No ethical authority now alleges that anyone has the right to keep another in slavery on the score that he gives him food and shelter." . . "We attribute natural rights to those whom we conceive as having the same kind of affections and instincts as ourselves. . . But how, on this view, does it stand with the claim of 'rights' for the lower animals? If we recognised rights inhering in them as in the inferior (human) races, it is clear we should not even feel ourselves entitled to keep them in forced service, much less to kill them; whereas, in point of fact, we do not even trouble ourselves to make sure that we have the 'right' to tame and work horses. The one check we (*i.e.*, men of normal temperament) recognise in the matter is in regard to over-working or ill-using them: there we have scruples; but that only amounts to saying that at a certain point we so far conceive similarity between us and the horse as to shrink from doing him serious injury. . . The 'right' to kill for food, again, can hardly be said to be seriously disputed, for even the extreme vegetarian would kill animals rather than let them overrun our fields; and it comes to be a question between breeding for slaughter and extermination on the other. . . All round, then, we make our own needs and interests our guides in dealing with animals, recognising no indefeasible right on their side because not holding that they feel as a breach of 'natural right' what would be a breach of that felt by a man. We forcibly tame and burden, we castrate (*i.e.*, vivisect), we kill by forced over-exertion, we kill for food: on what grounds then shall we deny ourselves the 'right' to give animals pain with the object of furthering knowledge?"

This is the inconsistency argument very forcibly put,—the argument out of whose meshes Bestiarians have never succeeded in wriggling. Hence Mr. Robertson is fully justified, as it appears to us, in writing:—"I am not aware of any argument on the (Bestiarian) side which can be pretended to meet that question, and their case, therefore, seems to me to break down as far as the appeal to our sense of 'right' goes.

He next undertakes the difficult task of enquiring into the origin of the Bestiarian fallacy which he has just dissected. The question of the origin of Bestarianism in general is about as difficult as, and is closely analogous to, the question of the origin of small-pox, syphilis, or leprosy. We cannot point out the social "microbe" who first originated this epidemic of irrationality. But upon the state of mind of some of the persons infected Mr. Robertson throws clear "cross lights." He quotes from a pamphlet written by "that wrathful controversialist Miss Frances Power Cobbe," the following characteristic passage:—

"The vivisection of dull (*sic!*) reptiles and wild rats and rabbits wherewith the elder generation of students contented themselves is not alone in question, nor even that of heavy beasts in our pastures; but by some strange and sinister fatality the chosen victims at present are the most intelligent and friendly of our domestic favourites—the cats who purr in love and confidence as they sit beside us on the hearth, the dogs whose faithful hearts glow with an affection for us truer and fonder than we may easily find in any human breast, &c., &c."

It must of course be remembered that there are here misstatements not a few; rabbits, guinea-pigs, and frogs are undoubtedly more frequently selected for physiological experiments than cats and dogs. "Heavy beasts in our pastures" are too expensive and too bulky. It may also be asked whether the purr of the cat is an expression of "love and confidence" or of satisfaction over comfortable quarters; whether the faithfulness and affection of the pet dog to its owner is not compensated by its spite against all other beings, human or infra-human, which it is capable of injuring or at least annoying.

But amidst all the Victoria Street cheers which Miss Cobbe's fervid periods may call forth let us listen to the calm, logical comments of Mr. Robertson. "All this," says he, "is transparent enough to those ruthless natures which are capable of exploring the quivering frame of this passage with the forceps and scalpel of dispassionate analysis. Miss Cobbe is a typical anti-vivisectionist in that she does what we have said the majority (of mankind) do not do—carry her sympathy with animals to the extent of attributing to them—or some of them—a moral and emotional nature closely resembling our own. She lets it appear very plainly that she is moved by purely personal sentiment as distinguished from an impartial sense of justice. Her dog and cat are a great deal to her, and it is the idea of their suffering which excites her. The exigencies of propaganda force her to be so far consistent as to protest against all vivisection and to deprecate 'sport;' but it is tolerably plain that if it were only dull reptiles, and wild rats and rabbits, and the heavy beasts of our pastures that were vivisected she would not be greatly concerned. That is, she is not defending a 'right' inherent in sentient things as such; *she is doing special pleading for some of them for which* she has a special liking. Her contention virtually is that cats and dogs have a better right to be spared than rats and rabbits, because they have the greater capacity for attachment to [some of] us. Now we have seen that we admit the 'rights" of men because we assume them to feel morally and physically as we should do in their place; but Miss Cobbe's argument to be relevant from that point of view would have to allege that we have cause to believe that dogs and cats under vivisection will feel both morally and physically as we do. We are entitled to believe, on the contrary, that their sensitiveness to pain is less, and that they have no moral feelings analogous to what a man's would be under the circumstances."

These sentences call for a few remarks. Dog-worship, or cynolatry as our contributor, Frank Fernseed, calls it, is the very backbone of the Bestiarian movement. Strange that an animal which owes its popularity mainly to the fact that it is willing to be the accomplice of the human species in cruelty—not to speak of another vice—should play such a part!

That the lower animals do not feel pain as do we is no mere assumption. Mr. E. Gurney wrote in the "Fortnightly Review" for December, 1881 :—"Dogs kept at physiological laboratories for the purpose of experiments display no such horror of the operating-room as was described in a sensational paragraph sent the round of the papers some time ago. A dog released from experiment has been known to jump up upon the operating-table and sit there to inspect a companion having his turn, showing that no very painful impression could have been left upon his mind by that he had undergone." The following incident, taken from "Physiological Cruelty, or Fact *v.* Fancy,"* is vouched for by an eye-witness :—

"A house-dog met with an accident by which a large piece of the skin and flesh above the eye-brow was cut and hung loose over the eye. His master, a surgeon, determined to stitch it. Now it is well known that—the skin being exceedingly sensitive—stitching is one of the most painful parts even of serious operations. The dog was taken into a shed, muzzled, and the cut stitched up. All the time it was being done he was straining and struggling to get away, though never whining nor crying. The instant he was released he dashed into a corner of the shed and seized a bone which he had had his eye upon, and which had possessed his soul while he had been undergoing the operation without anæsthetics."

Such cases, to which many more might be added, prove that even such comparatively highly developed animals as dogs are far less sensitive than is civilised man. It is doubtless true that every animal is sentient, and we should be very reluctant to deny the same attribute to plants. But there is a continuous and gradual fading away of sensitiveness from the higher forms of life to the lower.

(To be continued.)

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* Tinsley Bros.

VI. ON THE SUPPOSED GERMINATING POWERS OF MUMMY WHEAT.

By Henry King-Parks.

FROM time to time the alleged power of Egyptian wheat to preserve its vitality for an indefinite period, so as to produce a plant when sown after the removal of the grains from the mummy cases of the ancient Egyptians, has given rise to much controversy. Several writers have asserted that the growth of mummy wheat in England is an established fact; others that, although the evidence is not conclusive, yet it is not improbable that wheat, under certain conditions, is capable of germination after the lapse of thousands of years; whilst there are those who contend that the vitality of wheat is destroyed after a brief period, and that there is no authentic record of mummy wheat germination. My object is to state facts as I find them, instead of relying upon mere theory or assertions, and to give an impartial review of the *pros* and *cons* of the subject.

Now, first of all, it would, perhaps, be prudent to make some inquiry into the character of the natives of the country in which the mummy cases are procured. To their discredit, be it said, the Arabs are represented by our popular writers upon Egypt as being a deceitful race. They are also in the habit of unrolling the mummies in search of coins, &c. They would thus have an opportunity of introducing grains of modern wheat into the mummy cases, and as it would be to their advantage to invest the mummies with as much interest as possible, it may reasonably be inferred that they would not scruple to deceive purchasers by false representations. This fact would not, of itself, be sufficient to discredit the reputed instances of mummy wheat germination unless supported by more tangible evidence. We will therefore analyse the records of a few of the best known cases of supposed germination to see whether the results justify the conclusion that the grains planted were genuine samples of mummy wheat.

In a little book entitled "Botanical Rambles" the author states that during the process of unrolling a mummy at the British Museum many years ago, a few grains of wheat happened to fall out of the linen folds; these grains were picked up by a gentleman present, who planted them, and that although probably two or three thousand years had elapsed since they were placed there, yet the seed grew and became a healthy plant, producing stalks, each of which bore from *five to seven heads*. I cannot trace any evidence whether the case bore any external signs of having been tampered with, but assuming that the case appeared to be intact, the statement that the stems produced branching ears is of some importance, as there is absolutely no existing proof that this variety of wheat (*Triticum turgidum*) has any antiquity of origin. All the evidence on this point, as given in my treatise on "Ancient Wheat," * goes to prove that wheat with branching ears was unknown before the time of Pliny. Certainly no drawings of it have been found on the ancient tombs; and although Unger † believes it was cultivated by the ancient Egyptians, he furnishes no proof founded on either drawings or specimens. There is no evidence of the period to which the mummy belonged, as the statement that it was "probably two or three thousand years old" is too vague to base an opinion upon. Wheat with branching ears has been grown in Egypt for very many centuries, and if the date of the mummy under notice was subsequent to the time of Pliny it is probable (if the power of wheat to germinate when thousands of years old *be admitted*) that the case alluded to was a genuine one of mummy wheat germination. It must not, however, be forgotten that this variety of wheat is extensively cultivated in Egypt at the present time; and in the absence of reliable information as to how the mummy case was procured, and having regard to the thieving propensities of the Arabs and their untruthfulness, as well as to the opinions of eminent scientists concerning the vitality of wheat given further on, the case in question would need further corroboration before it can be accepted as authentic.

To the kindness of Mr. William Carruthers, F.R.S., of the British Museum, I am indebted for the knowledge of the next case to which I will refer; and through the courtesy of Mr. John Macgregor, M.A. (Rob Roy), I am favoured with particulars concerning it.‡ Mr. Macgregor's well-known accuracy of detail, and the high character of the gentlemen named, entitles the following to special prominence. On June 9, 1871, a wooden sarcophagus, brought from the Khedive of Egypt by the Duke of Sutherland, was opened at Stafford House by Dr. Birch of the British Museum, and

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* Ancient Wheat: Being a History of Wheat and its Products, from Prehistoric to Modern Times. Second (Illustrated) Ed. By Henry King-Parks.

† Unger. Die Pflanzen des Alten Agyptens, p. 31.

‡ Letter to the writer.

Mr. John Macgregor. The lid of the mummy-case seemed to have been unopened before, as the clay luting was in the joint nearly all round. From the hieroglyphics outside Dr. Birch pronounced the mummy to be that of a priest sacred to Osiris, and about 2600 years old; and he predicted there would be found inside several articles, a blue glass net, images, &c., which were found within. Among the loose *débris* inside the case were four grains of corn, two of these Mr. M. planted a few days afterwards in a small flower-pot filled with sifted mould from the Temple Gardens; the other two grains were sent to Mr. Sowerby, at the Royal Botanic Society, Regent's Park; the pot from the Temple was also sent to Mr. Sowerby, in August, with one of the grains grown up about eight inches high; this was returned in December, 1871, as a stalk four feet long, *with twelve grains of oats growing on it;* the other two grains grew up into several stalks, but without any fruit. In connection with this case it will be noticed that Dr. Birch pronounced the mummy to be 2600 years old, and that the seeds which vegetated produced *oats—a grain unknown to the Egyptians 2600 years ago!* This is unmistakable testimony that the Arabs are not only adepts in lying, but skilful manipulators of ancient sarcophagi, and has an important bearing upon the first, and the next case of wheat vitality.

The next, and perhaps most talked of, experiment is that of the Count of Sternberg, at Prague.* I take the particulars from A. de Candolle's learned work on "The Origin of Cultivated Plants." The Count of Sternberg had received the grains from a trustworthy traveller, who assured him that they were taken from a sarcophagus. Two of the seeds germinated, it is said, but M. de Candolle ascertained that in Germany well-informed persons believe there is some imposture, either on the part of the Arabs, who sometimes slip modern wheat into the tombs (even maize, an American plant), or on that of the *employés* of the Count of Sternberg. These three cases, and there are several others of less note, are cited as being good examples of the various experiments with supposed mummy-case seeds.

It is somewhat remarkable that almost all of the published accounts of the experiments are qualified by the statement that owing to the indifferent character of the Arabs it is not always certain that the seeds which have sprouted were really at first enclosed with the mummies. Thus, in "Vegetable Physiology," the author asserts that there is nothing improbable in the fact of ancient seeds germinating, but yet he gives expression to a doubt, such as the above. A. de Candolle,[*] too, says that "the thing is not impossible, for grains are all the better preserved that they are protected from the air, and from the variations of temperature or humidity, and certainly these conditions are fulfilled by the Egyptian monuments," but he also says that "*as a matter of fact, the attempts at raising wheat from these ancient seeds have not been successful,*" and, further, that "*no grain taken from an ancient Egyptian sarcophagus, and sown by horticulturists, has ever been known to germinate.*" Dr. F. W. Pavy,[†] the analyst, says:—"I see no reason that mummy wheat should not grow, as seeds if kept dry undergo no change. If wheat can be kept for twenty years with its capacity under exposure to the requisite conditions—warmth, air, and moisture—for assuming a state of active life, that is, passing from dormant to active vitality, there is no reason that it may not be kept for 100 years; and if for 100 years, no reason that it may not be kept for 1000 years, and upwards. Everything depends upon the conditions under which the grain of wheat is kept—whether antagonistic to change taking place in it or not;" but, adds Dr. Pavy, "*I do not know of any specific instance to refer to.*" The opinion of a gentleman occupying Dr. Pavy's position is entitled to respect, but it will be seen that the conclusions of the learned author and analyst are based upon theory, and that he has no ascertained facts to support his contention. Thus far, it would seem, 1st, that the best known cases of the supposed growth of ancient seeds of wheat have a considerable amount of suspicion attached to them; and 2nd, that those who assert that the seeds of wheat are capable of retaining their vitality for an almost indefinite period, when preserved under certain conditions, are unable to quote an authenticated instance of germination.

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* Journal Flora, 1835, p. 4.

As against these conjectures I will quote the opinions of our modern authors and scientists.

Mr. Villiers Stuart, M.P., an old traveller in Egypt, and author of "Nile Gleanings," writes thus:[‡]—"With regard to the passage about Egyptian Wheat, I beg to say there is no such thing in existence as mummy wheat that will grow. The vases full of mummy wheat which are sometimes found with mummies are invariably carbonised from age. The samples represented as having vegetated are due to the deceitfulness of the Arabs, who put modern wheat into the old vases and sell them to travellers. Nothing but a miracle could make mummy wheat germinate."

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[*] Origin of Cultivated Plants.

[†] Letter to the writer, January 18, 1884.

[‡] Letter to the writer.

Mr. William Carruthers, F.R.S., Consulting Botanist to the Royal Agricultural Society, says:*—" The statements in your papers as to mummy wheat are quite correct. I have examined many specimens in the British Museum, and I found every one incapable of germination. I have had a case of supposed germination investigated. Mr. John Macgregor, "Rob Roy," germinated, he believes, two mummy seeds, but the plants that grew were oats—a grain unknown to the Egyptians! A pea, also, was sent to me, said to have been grown from a seed taken out of a mummy-case, but on applying to the person who had taken it out he informed me that he had only the testimony of the Arab from whom he had got the peas. *No* case investigated has turned out to be trustworthy. As a matter of fact, the seeds of wheat are incapable of germination when they are ten or twelve years old."

Professor Sir Charles A. Cameron, M.D., President of the Royal College of Surgeons, Ireland, Chemist to the Royal Agricultural Society, Ireland, M.R.I.A., &c., writes explicitly thus:†—" I never believed that the so-called mummy wheat was really composed of seeds which had been deposited in the tombs of the kings of ancient Egypt at the time of their sepulture. So far as I can learn, it is alleged that the wheat found in the tombs germinated very satisfactorily. Now we know that it is only the best matured seeds of plants which satisfactorily germinate, and every seed-grower is aware that the vitality of seeds is influenced by many factors. The seeds produced under unfavourable climatic influences sometimes are incapable of re-producing their parent plants. Very old seeds are known, too, to be much inferior to those of recent growth. No doubt seeds retain their vitality for a very long period, but when thousands of years old, I am quite sure that the embryo plants which they contain could have no vitality left. One might as well suppose that an egg embalmed for a thousand years would be capable to produce a chick, when hatched, as to believe that organic matter could be associated with dormant vegetable life for a period of nearly forty centuries."

Sir J. B. Lawes, Bart., J.P., LL.D., F.R.S., F.C.S. (who, in conjunction with Dr. J. H. Gilbert), has written in the

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* Letter to the writer, February 7, 1884.

† Letter to the writer, January 17, 1884.

Journals of the Royal Agricultural Society of England, several valuable reports on field experiments, &c., upon wheat, including, "On some points in the Composition of Wheat Grain: its Products in the Mill and Bread;" "Report of Experiments on the Growth of Wheat for Twenty Years in succession on the same land;" "On the Home Produce, Imports, and Consumption of Wheat;" "Our Climate and our Wheat Crops;" "Another Paper on the Home Produce, Imports, Consumption, and Price of Wheat, &c.)," writes as follows:*—"I have not the slightest idea that the mummy wheat which was brought to this country a few years ago, and said to be thousands of years old, was anything except the modern wheat of the country. All the evidence we have upon the germination of seeds tends to prove that their power of germinating deteriorates very soon, and starchy seeds much sooner than oil seeds."

The late Dr. Augustus Voelcker, Chemist to the Royal Agricultural Society of England, &c., gave this opinion:†—"My father desires me to tell you that he does not know of a single authenticated case of mummy wheat having germinated after the lapse of so many years, and he regards it altogether as a myth the possibility of such germination ever having taken place. Even under most favourable conditions the vitality of wheat probably will not be preserved for a great number of years."

From an English newspaper I extract the following:‡—"Most people have heard the story of the astonishing vitality of wheat which had been wrapped up with an Egyptian mummy for ever so many thousand years, and a few persons may, perhaps, have been foolish enough to part with their money in the purchase of some grains that were advertised some time ago as 'Mummy Wheat.' The following reply to a question that was put to Sir J. D. Hooker a few days ago may interest them. He writes:—'The story of Egyptian mummy wheat having germinated has never been confirmed, and is not credited by anyone who is warranted by knowledge and experience in such matters to give an opinion. Innumerable attempts to stimulate mummy wheat into vitality have each and all failed.—Your obedient servant, J. D. HOOKER. Royal Gardens, Kew.'"

Further evidence of the same nature is forthcoming, but I consider that I have given sufficient to disprove the statement that the seeds of wheat can retain their vitality for the

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[*] Letter to the writer, January 8, 1884.

[†] Letter to the writer, from Mr. E. W. Voelcker, January 10, 1884.

[‡] *Marlborough Times*, July 11, 1885.

long period which they are popularly represented to have done when taken, as is supposed, from ancient mummies, and afterwards planted.

To sum up, it will be observed that Sir J. B. Lawes, one of our greatest living authorities upon Agricultural Science, declares that the power of germination deteriorates very soon, especially in starchy seeds; that Sir Charles A. Cameron, who has had very great experience as an Agricultural Chemist, asserts that the very old seeds are known to be much inferior to those of recent growth, and when thousands of years old he is *quite sure* the embryo plants which they contain could have no vitality left; that Mr. William Carruthers, head of the Botanical Department of the British Museum, who *examined many specimens in the Museum*, says he found *every one of them* incapable of germination; that the late Dr. Voelcker, Chemist to the R.A.S.E., did not know of *a single authenticated case*, and that he did not believe that the vitality of wheat could, *even under the most favourable conditions*, be preserved for many years; that Sir J. D. Hooker, of the Royal Gardens, Kew, whose valuable contributions to botanical literature have a world-wide fame, asserts that the innumerable attempts to stimulate mummy wheat into vitality have each and all failed; that the seeds found by Mr. John Macgregor, the talented author of "Rob Roy on the Jordan, Red Sea," &c.; in a mummy case, *bearing all the outward appearance of never having been tampered with* after being planted, produced *oats*; that all those writers who believe in the power of ancient wheat to germinate cannot refer to any specific instance, and admit, like A. de Candolle,* that the fradulent introduction of modern plants into the sarcophagi of the mummies is a possible source of error, this author relating an instance of the discovery of grains of maize (a plant of American origin) in one of the mummy cases, and which were introduced by the Arabs; and, lastly, that Mr. Villiers Stuart, M.P., an old traveller in Egypt, and who is intimately acquainted with the people of that country, emphatically states that the Arabs do not hesitate to enclose *modern* wheat in old vases, and such like antiquities.

Sandymount, Dublin.

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* Origin of Cultivated Plants.

VII. THE BRITISH ASSOCIATION AND SIR LYON PLAYFAIR'S PRESIDENTIAL ADDRESS.

THE future of the British Association is not quite unclouded. Its annual gatherings show no falling off in the number of attendance, nor are we aware that any lack of funds is threatened. The daily and weekly papers, provincial as well as metropolitan, still find it desirable to report the proceedings at considerable length. Special sermons are still preached to, or perhaps rather *at*, the Association wheresoever it meets. Last year's gathering at Montreal presents even some of the features of a notable progress, foreshadowing the rise of an Association for the Promotion of Science, which, if not absolutely international, will at least embrace not merely the United Kingdom, but the British Empire and the United States of America,—in other words, the English-speaking nations of the Globe. May it so fall out! But for all this it seems to us, and to not a few others, that a change of ill omen is gradually stealing over the meetings. It would be a delicate and an invidious task to decide whether the work done by the Sections has deteriorated in quality, but it certainly has fallen off in point of quantity, and in the number of hearers.

Eminent names will still draw a numerous audience, but a young *savant* who has not yet won his spurs will certainly not find the sectional meetings of the Association a fit opportunity for bringing his researches before qualified and appreciative listeners. On the other hand, the amusing features of the gathering, excursions, garden-parties, lunches, and what not come more into prominence, and, not content with the evening, are gradually encroaching upon the afternoon. The bread is decreasing to a poor halfpenny-worth, while the sack is becoming an intolerable deal. Hence there are those who—not scientific specialists, but observant men of the world—question whether the Association has in it another half-century's life.

Our immediate concern is not, however, with the general position and prospects of the British Association, but with the Inaugural Address of its President. Sir Lyon Playfair did not give, as some of his predecessors have done, a general picture of the most recent developments of Science, of the direction they are likely to take, and of their bearings on the various interests of society. He did not enter upon any controversy attacking or defending any contested theories. His subject, that of secondary education, however important, was one of not unquestionable relevance. Further, though many of his statements deserve the most eager and careful attention, he himself seems scarcely to have felt their full import. Had he done so he could scarcely have failed to draw and to emphasize certain conclusions of which we find only the slightest hint.

He points out our deficiencies in secondary education,—deficiencies, perhaps, in no small extent due to the fact that we have preferred to force primary education upon those who do not want it, at an untold cost, and we have a lack of funds for supplying higher education to those who crave for it. He says:—

"Various royal commissions have made inquiries and issued recommendations in regard to our public and endowed schools. The Technical Commission which reported last year can only point to three schools in Great Britain in which Science is fully and adequately taught. While the Commission gives us the consolation that England is still in advance as an industrial nation, it warns us that foreign nations, which were not long ago far behind, are now making more rapid progress than this country, and will soon pass it in the race of competition unless we give increased attention to Science in public education. A few of the large towns—notably Manchester, Bradford, Huddersfield, and Birmingham—are doing so. The working classes are now receiving better instruction in Science than the middle classes. The competition of actual life asserts its own conditions, for the children of the latter find increasing difficulty in obtaining employment. The cause of this lies in the fact that the schools for the middle classes have not yet adapted themselves to the needs of modern life. A return just issued, on the motion of Sir John Lubbock, shows a lamentable deficiency in Science teaching in a great proportion of the endowed schools. While twelve to sixteen hours per week are devoted to Classics, two to three hours are considered ample for Science in a large proportion of the schools. In Scotland there are only six schools in the return which give more than two hours to Science weekly, while in many schools its teaching is wholly omitted. Every other part of the kingdom stands in a better position than Scotland in relation to the science of its endowed schools.

"*As there is no use clamouring for an instrument of more compass and power until we have made up our mind as to the* *tune*, Prof. Huxley, in his evidence before a Parliamentary Committee in 1884, has given a time table for grammar schools. He demands that out of their forty hours for public and private study, ten should be given to modern languages and history, eight to arithmetic and mathematics, six to science, and two to geography, thus leaving fourteen hours to the dead languages. The great public schools of England will continue to be the gymnasia for the upper classes, and should devote much of their time to classical and literary culture. Even now they introduce into their curriculum subjects unknown to them when the Royal Commission of 1868 reported, though they still accept Science with timidity. Unfortunately the other schools which educate the middle classes look to the higher public schools as a type to which they should conform, although their functions are so different. It is to the interest of the higher public schools that this difference should be recognised, so that, while they give an all-round education and expand their curriculum by a freer recognition of the value of Science as an educational power in developing the faculties of the upper classes, the schools for the middle classes should adapt themselves to the needs of their existence, and not keep up a slavish imitation of schools with a different function.

"In the school the boy should be aided to discover the class of knowledge that is best suited for his mental capacities, so that, in the university, knowledge may be specialised in order to cultivate the powers of the man to their fullest extent.

"Passing from learned or public professions to commerce, how is it that in our great commercial centres, foreigners—German, Swiss, Dutch, and even Greeks—push aside our English youth, and take the places of profit which belong to them by national inheritance? How is it that in our colonies, like those in South Africa, German enterprise is pushing aside English incapacity? How is it that we find whole branches of manufactures, when they depend on scientific knowledge, passing away from this country, in which they originated, in order to engraft themselves abroad, although their decaying roots remain at home? The answer to these questions is that our systems of education are still too narrow for the increasing struggle of life.

"The opponents of science education allege that it is not adapted for mental development, because scientific facts are often disjointed and exercise only the memory. Those who argue thus do not know what Science is. Scientific and literary teaching have different methods; for while the teacher of Literature rests on authority and on books for his guidance, the teacher of Science discards authority and depends on facts at first hand, and on the book of Nature for their interpretation. Natural science more and more resolves itself into the teaching of the laboratory. In this way it can be used as a powerful means of quickening observation, and of creating a faculty of induction after the manner of Zadig, the Babylonian described by Voltaire."

Sir Lyon Playfair complains, with the fullest justice, that in our schools and colleges the time and the facilities devoted to the study of Science are insufficient in themselves, and still more insufficient—as he notices in subsequent portions of his Address—in comparison with those of rival nations. But we must call especial attention to the words which we have italicised. The foreign educational systems play a "tune" differing from ours not merely in the time and money expended, but in another point perhaps even more important. *Their* teachers of Science are not paid by so-called "results." Their college curricula do not involve a constant preparation for examinations. The principle of competition plays no prominent figure. They have no merely examining universities. Now, as Sir Lyon Playfair admits our inferiority, it seems strange that he does not weigh, one by one, all the points on which the British and (say) the German systems of education respectively differ, to decide where the blame must fall. Is it not, at any rate, possible that the fault lies here? And, if so, no possible increase of time and expenditure will get over the difficulty. Why is it said with truth that the senior boys in a grammar school learn Science less easily than the juniors? Why are we told that the boys who shine at school disappear at the university, and that the shining lights of the university disappear, in turn, in after life? This is not the case in Germany: the brilliant student—recognised as such by his power not of passing "exams," or of being easily crammed, but by his faculty for conducting research—becomes in after life the still more brilliant *savant*. Perhaps the "English incapacity" of which Sir Lyon Playfair complains has been laboriously instilled into the unfortunate youth at school and college. "All the brains," as an eminent friend of ours says, "have been examined out of him."

The President of the British Association tells us that—"Either all foreign States are strangely deceived in their belief that the competition of the world has become a competition of intellect, or we are marvellously unobservant of the change which is passing over Europe in the higher education of the people."

Might he not have said, in like manner, that "either all foreign States are strangely deceived in their belief and practice, or we are marvellously astray in maintaining and extending our examinational system." He says most truly:—"Universities are not mere storehouses of knowledge; they are also conservatories for its cultivation. The widening of the bounds of knowledge, literary or scientific, is the crowning glory of university life. Germany unites the functions of teaching and research in the universities, while France keeps them in separate institutions. The former system is best adapted to our habits, but its condition for success is that our science chairs should be greatly increased, so that teachers should not be wholly absorbed in the duties of instruction. Germany subdivides the sciences into various chairs, and gives to the professors special laboratories. It also makes it a condition for the higher honours of a university that the candidates shall give proofs of their ability to make original researches."

"Unless English colleges have such ambition they may be turned into mere mills to grind out material for examinations and competitions. Higher colleges should always hold before their students that knowledge, for its own sake, is the only object worthy of reverence."

Here Sir Lyon Playfair admits much of the truth, but he still falls short of the one final step. He still says "the Department of Science and Art is doing excellent work," and speaks of the "excellent school in South Kensington."

Now the "Department of Science and Art" has been at work for many years, and has been entrusted with the expenditure of a very considerable sum of public money. And what have been the "results"? We shall venture to guage them by an unusual, but we think perfectly fair, standard. Not a few authorities have pointed out, as one of the most alarming symptoms of our national inferiority, the number of aliens who find employment in Britain, the alleged reason being the incompetence of natives. Now has this number at all decreased since the establishment of the Science and Art Department? Has it shown any tendency to decrease? Is it not still increasing? And if such be the fact, what is the only legitimate inference? Suppose a physician has gone on for a long time treating his patient in a certain manner, but finds him, if anything, getting worse: will he still persevere with increased doses, and if he does so will he not be "pushed aside" for incapacity? We fear that if the higher officials of the Department were paid by results there would be weeping and wailing at South Kensington. But Sir Lyon Playfair does not see all this: we fear he is too deeply committed to the competitive and examinational system. We have, with unspeakable regret, found him connected with the attempt to resist the movement against over-pressure. For one of the characteristics of the English system of education is, that it wastes not merely time and money, but nerve-power and intellect.

If we were asked how to reform this vicious system from top to bottom, we would say—Disband in the first place the Committee of Council on Education and the Science and Art Department, and commit their duties to a Minister of Public Instruction, who must, whatever other qualifications he possesses, be an eminent physician. Do away with payment by (pseudo)-results and with the "standards," and with every other feature which aims at stereotyping human beings. Divide the universities from the very outset into faculties, each student to declare the faculty which he selects. No student to be compelled to take up any subject not included in his faculty. Examinations to be required merely in the case of candidates for professions under State control, such as lawyers and medical men. Degrees, fellowships, and other honours to be earned only by successful research, and not by mere proficiency in producing the results of others. Rise in the professions, such as the Army Medical Service, not by renewed examinations, but *rebus gestis*. Finally, laboratories—physical, chemical, biological—under competent instructors everywhere; preparing for examinations, coaches, and cram-books nowhere. Let these changes be made, and there will be no scope for alien men of Science in Britain.

But why dream of the nation thus coming to its senses? We shall go on establishing more and more examinations, training youth to talk about things in place of doing them, until we take the place in the civilised world which China seems likely to abandon.

ANALYSES OF BOOKS.

On the Sensations of Tone as a Physiological Basis for the Theory of Music. By HERMANN L. F. HELMHOLTZ, M.D., Foreign Member of the Royal Societies of London and Edinburgh. Second English Edition. Translated, thoroughly Revised and Corrected, rendered conformable to the Fourth (last) German Edition of 1877, with numerous additional Notes and a new additional Appendix, bringing down information to 1885, and especially adapted to the use of Musical Students, by A. J. ELLIS, F.R.S., &c. London: Longmans, Green, and Co.

WE have here an extraordinary work, the production of an author who combines attainments rarely met with in one and the same individual. Having been formerly Professor of Physiology in the University of Heidelberg, he now fills, with distinction, the Chair of Physics in that of Berlin. This fact already bespeaks no small degree of versatility, since it is generally found that the physicist and the physiologist belong to two very distinct mental types. But this is by no means all: Professor von Helmholtz is theoretically, if not also practically, a musician. Had he not been such, the work before us could never have been written.

Mr. Ellis, the translator, is also evidently a man of no small degree of versatility. That he is a musician is a matter of course. On the title-page he is described as "twice President of the Philological Society," and "Member of the Mathematical Society." Had he been a specialist, limited to his speciality,—or, as the Americans profanely put it, "a one-horse man,"—he could never have succeeded in producing a satisfactory version of Prof. von Helmholtz's "Ton-Empfindungen."

In his Introduction the author discusses the relations subsisting between physical and physiological acoustics on the one side, and of musical science and æsthetics on the other. These different disciplines have remained hitherto widely apart, and without any special influence the one upon the other. He argues that music stands in a much closer and more immediate connection with pure sensation than in any other of the fine arts. Hence the theory of the sensations of hearing is destined to play a much more important part in musical æsthetics than does, for example, the theory of chiaroscuro, or of perspective in painting. He writes:—"When in hearing a concert we recognise one tone as due to a violin, and another to a clarionet, our artistic enjoyment does not depend upon our conception of a violin or a clarionet, but solely on our hearing the tones which they produce, whereas the artistic enjoyment resulting from viewing a marble statue does not depend on the white light which it reflects into the eye, but upon the mental image of a beautiful human form which it calls up."

The author further points out the distinction between physical acoustics, which is essentially nothing but a section of the theory of the motions of elastic bodies, and physiological acoustics. He shows that inquiries into the processes of any of our sense-organs have generally three distinct parts. First, we have to discover how the external agent reaches the nerves to be excited. This may be called the physical part of the investigation. Secondly, we have to investigate the various modes in which the nerves themselves are excited, giving rise to their various sensations. And thirdly, the laws according to which these sensations result in mental images of determinate external objects,—that is, in perceptions. Thus we have a physiological investigation for sensations, and a psychological investigation for perceptions. The results obtained for the physiological and psychological sections of the theory of hearing are but few, imperfect and accidental.

The first part of the work before us is essentially physical and physiological, containing a general investigation of the phenomenon of harmonic upper partial tones. The second part treats of the disturbances produced by the simultaneous production of two tones. The third part discusses the construction of musical scales and notes, and consequently falls within the sphere of æsthetics.

A Handbook of Practical Telegraphy. By R. S. Culley. London: Longmans, Green, and Co.

This work, having already reached its eighth edition, can scarcely be regarded as amenable to criticism. All persons who feel an interest in electric telegraphy—which alone falls within the author's plan—will have already formed an opinion upon it, mainly favourable.

The author considers in succession the sources of electricity, the laws of the current, the Earth as part of a circuit, magnetism and electro-magnetism, static and dynamic induction, atmospheric electricity and earth-currents, the construction of telegraphs, testing, signalling, and submarine telegraphy.

We note the remark that "public opinion" will not tolerate the erection of telegraph-poles in the streets of towns. We should rather be disposed to say "public convenience." If in the carriage-way they and their systems of wires might interfere with traffic; and if in the footway, and consequently near the houses, they might prove serious hindrances to the manipulation of fire escapes, ladders, &c. Indeed, objectionable as wires are when stretched over the tops of houses, they are still more to be deprecated if traversing the streets at lower altitudes. The recommendation that when a street must be crossed it should be at right angles, so as to decrease the span and thus lessen the risk to passengers, by no means meets with general attention. It is undoubtedly true that the number of accidents has hitherto been very small, but it is likely to increase in course of time as the wires get older. In cases of heavy snow-storms and of conflagrations, there is here a very serious risk.

It is curious that the industry of spiders occasions no small annoyance. Their webs often collect dust and moisture, and thus increase the unavoidable loss at the insulators.

A curious trait of human—or at least of juvenile—character is mentioned in connection with insulators. "The dark colour and unpretending appearance of a small ebonite insulator protect it greatly from wilful damage. It is found that in localities where the telegraph is exposed to mischief, a large white porcelain insulator is quickly broken, earthenware is less quickly attacked, and a small ebonite insulator not at all. Mischievous boys cannot hit the small mark with stones, nor does it tempt them by its inviting appearance. Many who would not take the trouble to break an unpretending black cup cannot resist the temptation of throwing at a large white one.

Solutions of the Questions on Magnetism and Electricity set at the Intermediate Science and Preliminary Scientific Pass Examination of the University of London, from 1860 *to* 1884. By F. W. LEVANDER, F.R.A.S., Assistant Master, University College School, London. Second Edition, Corrected and Enlarged. London: H. K. Lewis.

THIS is a work which does not commend itself to our sympathies. We believe it to be an outcome of a vicious system, with whatever ability it is worked out.

The author states, in his Preface, that "Persons desirous of presenting themselves for Examinations are deterred from doing so by a want of some further information *as to the requirements of the Examiners* than can be gained from a mere syllabus, or from the inspection of a few examination papers."

The words which we have italicised seem to us to convey an admission that in Electricity and Magnetism, and by a parity of reasoning in other branches of Science, a knowledge of the subject-matter is insufficient without an acquaintance with the idiosyncracies of the examiners. In other words, it accentuates the fact that to "know" and to "pass" are not connected together by any essential necessity.

In a laudatory notice of the first edition of this little work, by a medical contemporary, we find also the following significant remark:—"Many students fail from a want of knowledge how to put their answers concisely into words." This is another impeachment of the modern English educational system, all the more telling because strictly unintentional. It is tantamount to a confession that an acquaintance with any subject is insufficient if the student lacks the power of talking about it in a certain approved style.

If we waive, however, these principial objections we find that Mr. Levander has executed his task exceedingly ably. His book will be unquestionably useful and welcome to those—and they are not few—whose tastes or whose necessities make the passing an examination seem to them a desirable object. The treatise is in fact a "coach," consisting of paper and ink instead of flesh and blood.

The Harz Mountains: their Geological Structure and History. By H. M. Cadell, B.Sc., of the Geological Survey of Scotland.

THIS memoir is a reprint from the Proceedings of the Royal Physical Society of Edinburgh. The author points out in the outset that the Harz is, like the Alps, Pyrenees, and Himalayas, a mountain system of elevation, and not, like the Norwegian mountain mass or the Scottish Highlands, a table-land of denudation. Its culminating point, the Brocken, of uncanny memory, is 3746 feet in height, but is supposed to have been at one time much more elevated. The area now occupied by these mountains is described as having been during the Palæozoic period a portion of the sea, in which the Silurian, Devonian, and Lower Carboniferous formations of Central Europe were deposited. The rocks with their fossils show changes in the depth and condition of this sea, but they form throughout a perfectly conformable system. In the Devonian period there was vigorous volcanic action, with protrusion of diabases and tuffs. About the close of the Lower Carboniferous the sea became shallower, the rocks which had been formed below the sea were upheaved in a series of folds trending generally from N.E. to S.W. Next followed the irruption of great bosses of granite; after which the region was dislocated by powerful faults. The fissures thus produced have since been filled with the metallic veins of the Upper Harz. About the end of the Lower Permian the volcanic action ceased, and submergence began. During the Cretaceous the Mesozoic rocks were rent by a great fault in the direction from E.S.E. to W.N.W. On the southern side of this fault the rocky mass of the Harz was upheaved to its present height. Since that date the Harz has not been again submerged, but it has been apparently covered—in part at least—by the great ice-sheet during the greatest intensity of the Glacial epoch.

The work is illustrated with a geological sketch-map of the district and a series of sections, and is enriched with a bibliography.

Geological and Natural History Survey and Museum of Canada. A. R. C. SELWYN, F.R.S., F.G.S., Director. Report o Progress, 1882, '83, and '84.

THIS bulky volume comprises, in addition to summary reports on the operations of 1883 and 1884, a report on the Geology of the country near parallel 49° N., west of the Rocky Mountains, from the observations made by H. Bauerman; a report on the region in the vicinity of the Bow and Belly Rivers, in the North-West Territory; report on the basin of the Athabasca River; geological observations in the Saguenay region; observations on the Labrador coast, Hudson's Straits, and Bay; explorations and surveys on the Gaspe Peninsula and Prince Edward Island, and a continuation of the survey of the Gaspe Peninsula; explorations and surveys of York and Carleton counties, New Brunswick; Geology of Northern Cape Breton; Apatite deposits of Ottawa County, Quebec; gold-mines of Lake of the Woods; observations on mines and minerals in Ontario, Quebec, and Nova Scotia; analysis of coals and lignites of the North-Western Territory; and contributions from the Laboratory of the Survey.

The volume has two practical defects: it has no Index, and each of the "Reports" of which it consists is paged separately.

Catalogue of Canadian Plants. Part II., Gamopetalæ. By JOHN MACOUN, F.L.S., F.R.C.S., Botanist to the Geological and Natural History Survey of Canada. Montreal: Dawson Bros.

THIS Catalogue will, when completed, prove an exceedingly valuable document. It is to be noticed how many European species—and always, as far as we have noticed, such as are least desirable—have not only become naturalised in Canada, but accompany the settler wherever he has penetrated. Concerning certain plants a doubt may prevail whether they are truly indigenous or have been imported.

The flora of British Columbia seems to approach that of Europe more nearly than does that of the more eastern parts of the Dominion. Thus *Vaccinium myrtillus*, for which the English names whortleberry and bilberry are given as synonyms, is peculiar to the Rocky Mountains, and thence onwards to Alaska. Over all the northern half of Europe it is well known to be common. *Calluna vulgaris*, the common European heather, seems to be found only in the extreme east of the Dominion, and there in but few localities, as if introduced from Europe. No true *Erica* has been found. *Ledum palustre* (marsh rosemary of Europe, Labrador tea of America) seems as abundant in the Nearctic as in the Palæarctic region. *Primula vulgaris* and *P. officinalis* are spoken of as "well-established," both in Vancouver Island and the latter at Cape Breton.

Rich scope for confusion has been given by the practice, common in all colonies, of giving the trivial names of European plants to native species. Of course they may be distinguished by the botanical names, but these are known only to a minority.

The Geological and Natural History Survey of Minnesota. By N. H. WINCHELL, State Geologist. First Annual Report, 1872; Tenth Annual Report, 1881; and Eleventh Annual Report, 1882.

THE first of these reports begins appropriately enough with a notice of earlier explorations, topographical and geological, in the regions which have now become the State of Minnesota. Then follows a summary of the general principles of geology. The elevations of the country above the respective levels of Lake Superior and the ocean are taken chiefly from railway-surveys. This, we think, is scarcely legitimate, since railways as far as possible avoid the more elevated regions.

We find here an analysis of the water of Lake Superior, which is of remarkable purity. The total weight of solid matter in solution is only 2·66 grains per gallon, no organic matter being mentioned as present, though it is added that the permanganate test showed 0·35 part of oxygen consumed by organic matter per million parts of water. The hardness is only 3·5 degrees, and phosphates are absent.

Judging from the three parts before us, Natural History plays no important part in the Survey. We find no account of the flora of Minnesota, and in Zoology there are merely three papers on Crustacea,—*viz.*, the Cyclopidæ of Minnesota, with notes on other Copepoda ; the Cladocera of Minnesota ; and on Notodromas and Cambarus.

In the Tenth Report there is complaint concerning the frequency and destructive character of forest fires. Special legislation is recommended, and joint action with the Dominion Government is suggested, since the fires begin on both sides of the boundary.

Facts proving that Lightning is a Composite Force. By W. Boggett. London : Ridgway.

In this pamphlet the author adheres to a view which he has expressed in a former publication, *viz.*, that water does not consist of oxygen and hydrogen alone, but likewise of electricity. This hypothesis seems to us to involve the materiality of electricity He does not, however, say that he has experimentally proved this proposition. He says—" Some few, indeed, have been told that it is composed of two explosive gases, but very few trouble themselves to ask how such gases (if water contained nothing else) could possibly extinguish fires, or how they came to be fluid." Now water is not composed of two explosive gases ; neither oxygen nor hydrogen is, *per se*, explosive. If a light is applied to them when mixed they burn with an explosion.

The author does not show how or why the presence of electricity as a constituent should enable water to extinguish fires, or render it fluid. He tells us that Faraday proved that ice is a non-conductor of electricity. *Dry* ice is certainly a very bad conductor, though there are not a few substances which conduct electricity still worse. But when melting it conducts *better* than water. Mr. Boggett is exercised by the fact that water when freezing exerts great force if confined,—that is, in a vessel which gives no room for expansion. But what objection can he make to the common explanation that water in freezing assumes a crystalline form, and being thus expanded becomes specifically lighter,—just as solid tin floats upon melted tin? But there is no need to reproduce arguments which have been already used in dealing with the author's former pamphlet, and which, though expressed without any discourtesy, drew from him not experimental proof, but merely an angry letter. The moment he can give in favour of his theories any better evidence than declarations of inconceivability, we shall not be slow to acknowledge his merits.

Bulletin of the United States Geological Survey. Nos. 2 to 6. Washington: Government Printing-Office.

The second number consists merely of "gold and silver conversion tables," showing the coining values of ounces of fine metal.

No. 3 describes the fossil faunæ of the Upper Devonian along the meridian of 76° 30′ from Tompkins County, Pennsylvania, to Bradford County, New York, by H. S. Williams. The author makes some useful remarks on the study of fossil faunæ. He says:—"We find that in the present ocean the depth of water, the temperature, the degree of saltness, and the freedom from organic impurities, have all a marked influence upon the normal fauna of every part of the ocean. Further, we find that on the two sides of an ocean, on opposite coasts of a continent, and even along a continuous coast-line, in two regions separated by a few degrees of latitude, the faunæ are characteristically different; and when these geographical areas are far separated, although under similar conditions otherwise, the faunæ may contain scarcely a single species in common. The revelations made by deep-sea dredging are also very suggestive. They have shown us that, with all these differences in the upper faunas in the depths of the ocean, species may range from one quarter of the globe to the opposite quarter with scarcely a varietal modification, and when the physical conditions have been continuous geological ages are not too long for the perpetuation of species without important modification. The wonderful effects produced by ocean currents upon the distribution of faunas is brought forcibly to our attention by the reports of our Fish Commission. Their investigations reveal the existence of an abundant fauna within a hundred miles of the New England coast, entirely distinct from the fauna prevailing all along that part of the coast out to deep water; and further, this unique fauna, which at the time of its discovery was composed of a large number of species and a great abundance of individuals, has now apparently left the region altogether. From this we learn that in a very small geographical area we might find the remains of two entirely distinct faunas, preserved in two strata of a continuous formation lying the one immediately upon the other conformably, yet geologically entirely contemporaneous."

No. 4, by Dr. C. A. White, gives a description of certain aberrant forms of the Chamidæ, from the Cretaceous rocks of Texas; also of a collection of Mesozoic fossils from Alaska, and an account of the Nautiloid genus *Enclimatoceras*.

No. 5 is a dictionary of altitudes in the United States, very useful for reference; and No. 6 is a table of elevations in the Dominion.

Our Corner. A Monthly Magazine of Fiction, Poetry, Politics, Science, Art, Literature. Vol. VI., No. 3. September 1, 1885. London: Freethought Publishing Company.

MR. J. HORNER continues his ably-written instructions for amateur microscopists. In this chapter he treats of solutions and mounting media.

The "Luminiferous Ether," by Laurence Small, is a good exposition of the views held by modern scientific leaders, and will be regarded as an abomination by the "Substantialists," the men who have arisen to set everyone and everything to rights.

From a contemporary is quoted the strange proposal to improve the weather of Western Europe by means of a floating breakwater, moored, we suppose in Davis's Straits. Some years ago it was proposed in this "Journal" to block up these Straits by blasting the rocks on both shores, and causing them to fall into the sea.

CORRESPONDENCE.

⁂ The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

ATTACKS OF THE COMMON GREEN APHIS.

An observation made by the Editor on page 558 of the "Journal of Science," on the possibility of the common green aphis attacking man, is confirmed by my own experience. In my garden is a large elm, with a seat around it. I commonly sit on this to read in the shade. During the dry period which prevailed in July and August I have been ignominiously driven from this position by the Aphides which swarmed in the tree. Their bite produced an irritation corresponding with that described, and the backs of my hands were especially visited. They are very pretty creatures in this winged stage, but by no means loveable. Since the recent rains I am able to return to my favourite seat.

W. Mattieu Williams.

Stonebridge Park, September 5, 1885.

A SEA-SERPENT.

The following paragraph appears to be going the round of the papers:—

"The Quebec ship *Emblem* (Capt. Roberts), from Rangoon, arrived at Queenstown on Sunday morning. The captain states that on August 5th, at 10 o'clock in the morning, and when in lat. 29·35° N., and long. 34·60° W., the mate drew his attention to a sea-serpent which was lying on the surface of the water about 9 feet from the ship's side. It measured no less than 55 feet in length, and about 7 feet in circumference. It was of a light pink colour, and during the time (fifteen minutes) that the crew saw it, its head, which was as big as that of a calf, was slightly raised out of the sea. Several times its mouth opened, disclosing fangs about 4 inches in length. When first seen by the mate it was lying quite motionless, but the water from the bow of the ship startled it. The weather was good, with a slight wind blowing, the *Emblem* scarcely making four knots."

Whilst holding that the existence of large marine serpents is simply a question of evidence, and cannot be pronounced impossible on *à priori* grounds, I find the above narrative not quite free from suspicion. A head only the size of that of a calf would be very ill adapted for fangs "about 4 inches in length."

Serpent-Hunter.

THE EXTERMINATION OF INSECTS.

In your recent article, "A Glance at Epping Forest," I suspect that you are a shade too severe on the Conservators. Their doings have not been always judicious from the Naturalist's point of view; but the drainage of the Forest cannot have been the sole cause of the disappearance of certain Lepidoptera, since a similar extirpation is going on at other places within an easy distance of London. Thus a few years ago *Zygæna filipendulæ* was not uncommon about Edmonton. *Euchelia jacobeæ* has disappeared from some of its former haunts. Darenth Wood, formerly the Mecca of collectors, is now often "drawn blank." I suspect the main cause of the mischief is the number of boys who have been led to take up not Entomology, but insect-hunting, by the perusal of a certain cheap natural-history paper.

Zeta.

ARE SPIDERS SHORTSIGHTED?

From the fact that a spider, especially an *Epeira*, detects the exact locality of an insect caught in its web by applying its feet in succession to the radial lines, it has been inferred that the creatures must be very shortsighted. A fact observed this morning makes me doubt this view. In a neighbour's garden a line supported on posts had been put up yesterday, for the purpose of drying linen, &c., and had been left out all night. On looking over some trees trained against the wall of my garden, and distant about 5 feet from the line, I saw that several Epeiras had carried their webs from the tops of these trees, and from the wall itself to the line. If spiders are shortsighted, how did they become informed of the existence of the line at a convenient distance for their spinning operations?

A Suburban.

DISCOVERERS AND TEACHERS.

In Sir Lyon Playfair's Presidential Address to the meeting of the British Association I find a very questionable assertion. The speaker declared that "In England our discoverers have generally been teachers," and added "I recollect only three notable examples of men who were not—Boyle, Cavendish, and Joule." It seems that he must have forgotten the names of Darwin and Wallace, of Lyell, Murchison, Bates, Belt, Sorby, Pennant, Waterton, White, Crookes, De la Rue, and, I believe, Huggins, Robert Brown, and the two Hookers. These names come into my mind without any searching for, but it is my belief that if the lives of our chief men of Science were collated, it would be found that only a minority of them occupied professorial chairs.

Veritas.

NOTES.

The cost of the Laboratories attached to the University of Strassburg has been £211,900.

M. Thollon has laid before the Academy of Sciences a new design of the solar spectrum. The upper band, No. 1, gives the aspect of the spectrum when the Sun is at 80° from the Zenith, and for a mean hygrometric state of the atmosphere. No 2 represents the spectrum when the Sun is at 60° from the Zenith and the air is very moist. No. 3 corresponds to the same distance from the Zenith and to a very dry atmosphere. No. 4 contains the prolongation of all rays of exclusively solar origin, as they would be seen outside the atmosphere.

From correspondence in "Science" it appears that the exact nature of the American Silurian scorpion is still in dispute.

Mr. E. L. Nichols ("American Journal of Sciences") has been experimenting on the sensitiveness of the eye for low degrees of saturation of colours, and among other important results finds that the male eye is more sensitive to red, yellow, and green, whilst the eye of the female is more sensitive to blue.

The custom of preaching *at* the British Association has been duly observed at Aberdeen. The Rev. Prof. Candlish was one of the orators who came forward.

The representatives of the Press complain of a want of courtesy at the Aberdeen Meeting.

Dr. D. Sharp, in a paper recently read before the Philadelphia Academy, seeks to trace the development of the vertebrate eye from the simplest deposit of pigment in an epithelial cell.

Mr. C. H. Murray ("Science") brings home another sin to mosquitoes. He has observed them attacking and destroying newly-hatched trout.

Mr. J. J. Colman and Prof. McKendrick find it impossible to permanently sterilise animal matter by exposure to the low temperatures now at the command of physicists. The microbia survive the cold. Even a frog has been found to recover after having been frozen solid by exposure for half an hour to temperatures of −20° to −30° F.

According to M. Oustalet the fauna of M. Comoro proves that this island has never had a land connection with Madagascar.

Mr. F. M. Slack (" Science "), writing on colour associations with months, mentions a relative of his who connects June with green, October with light crimson, and December with blue.

A. Becker (" Mineral. Mittheilungen ") maintains, after a prolonged series of experiments, that calcium carbonate in its various natural forms—chalk, arragonite, calcite, &c.—may be converted by heat into a granular limestone, but (at least under the conditions of the experiment) cannot be liquefied, or even softened.

The Lick Observatory, from the extraordinary clearness of the surrounding atmosphere, will enable instruments of the highest magnifying power to be successfully used.

According to Dr. Carl Seiler some persons have a defect of smell analogous to colour-blindness. One person finds that to him violets smell like garlic, everything else smelling normally.

Mr. J. Starkie Gardner, F.G.S. (" Geological Mag."), discusses the possibility of utilising subterranean heat for industrial and domestic purposes.

In a paper on Siberia, the late Dr. Alfred Brehm makes the startling assertion that " The mean temperature is not high enough perfectly to ripen grapes, but oranges grow well in the southern parts." This statement must be received with caution, considering that the orange tree requires a higher temperature than the vine, and is nowhere found able to live and fruit in the open air so far north as 50°.

A specimen of the anaconda (*Eunectes murinus*), 6 metres in length, is now to be seen at the Jardin des Plantes, at Paris.

In refutation of the common opinion that parrots attach no meaning to the words which they utter, we give the following fact:—A child in a neighbouring garden having set up a loud and very cat-like scream, our favourite parrot, a West Coast grey, at once exclaimed " Puss, puss, puss ! "

" Cosmos les Mondes " asserts that the chief motive for cremation is hostility to Catholic tradition.

According to C. H. Merriam (" American Naturalist ") the Oregon mole, *Scapanus Townsendi*), especially after being soaked in alcohol, displays iridescent colours—purple, lilac, and bronze.

At Rome the proportion of the sexes is very different from that prevailing in England : there are 100 men to 95 women.

In the beginning of last month an exceedingly fine and fresh specimen of *Sphinx convolvuli* was captured in Hornsey Road, by a man employed at the Brush Works. It is now in the possession of Mr. J. Mutch, chemist, of Hornsey Road.

Mr. J. T. Campbell ("American Naturalist") refutes by observation the common notion that the rings of trees register fruitful and unfruitful years.

A notion prevails in Brazil that the *gitiranaboia* (*Fulgora lanternaria*), a perfectly harmless insect, has the power of killing large animals, and even trees, with the touch of its beak.

Taking a ramble along the banks of the Lea, just below the Tottenham Sewage Works, we were saluted by two rough-looking youths with the questions—"Come down to smell at it?" "Aint it strong?"

The teeth of recent animals contain very little fluorine, whilst it is largely present in fossil teeth.

To test the now prevalent opinion concerning the origin of cholera, M. Rochefontaine took a certain quantity of the dejections of a cholera patient containing the celebrated comma-bacillus, and made them into a bolus, which he swallowed. He was not seized with cholera.

A revival of Astrology seems in contemplation. Would it not be possible, as *experimentum crucis*, to find in London two children born at the same time and within a distance of a few yards only, and to compare their destinies in life?

Luiz de Andrade Corvo, in a communication to the Academy of Sciences, contends that the destruction of vines ascribed to the *Phylloxera* is really due to a tubercular disease occasioned by a special bacillus. This disease can be communicated to other plants by inoculation in the entire absence of the *Phylloxera*. This insect merely spreads the evil of inoculation.

Mr. K. A. Chipman ("Science") mentions a case of three children who associated colours with the names of persons, Kate seeming to them red, Mary white, Alice violet, Dick deep Vandyke brown, William a watery blue.

At the September meeting of the Entomological Society, Mr. Waterhouse, of the British Museum, exhibited some aquatic Curculios which swim with the same action and the same ease as a *Dytiscus*, though their legs display no structural adaptation for the purpose.

A certain writer asks—Supposing it asserted that the Moon is made of green cheese, could our *savants* furnish any absolute refutation of the assertion?

A curious poisoning case has come under our notice: a cat which had obtained possession of a sole, and eaten it, became almost immediately very sick, and died before night. The fish had just been bought for human consumption, and the cat—as it may be fairly inferred from her good appetite—was in average health.

The so-called "harvest-man," or "harvest-spider" (*Phalangium*), has been this year very numerous upon kidney-beans infested with black Aphides. Whether it is making war upon this pest, or whether it feloniously attacks the ladybirds, also numerous, is undecided.

The German Congress of Naturalists and Physicians is composed of members and associates, the former alone having the right of voting. Only persons who have written books on some department of natural science, or medicine, are admissible as members. This arrangement, if carried out literally, will of course admit mere compilers.

From the recent proceedings at Southport it is plain that a large proportion, at least, of the working classes are not in favour of the Sunday opening of museums.

Prof. Chrystal, in his Address to the Mathematical and Physical Section of the British Association, admits that "competitive examinations work all this mischief in our educational systems," and speaks of the opportunity of "dethroning the iron tyrant Examination."

According to the "Electrical Engineer," "that vaunted home of education at South Kensington is a hot-bed of something of a very different name, and money that ought to be expended in gaining information for public use goes in directions known to but very few besides those in whose direction it does go."

M. G. Bigourdan ("Comptes Rendus") announces that until lately the nebula of Andromeda had a nucleus comparable to a star of the 10th or 11th magnitude. Almost in place of this small body, but distinct from it, there is now a fine star of the 7th magnitude.

Tanquin, the ordeal poison of Madagascar, has been examined by C. E. Quinquand. It affects in the first place the central nervous system, augmenting especially the bulbo-spinal reflectivity. The animal dies by arrest of respiration, the heart continuing to beat.

Prof. J. P. Lesley, in his Presidential Address at the late meeting of the American Association, says, rather strangely, "Let us avoid the sacrifice of character to Science."

The same *savant* said—"The idea of universal education is wholly modern." What of ancient Athens?

W. W., writing in the "Kansas City Review," shows that in industrial art "the ancients" approached us far more nearly than is commonly believed, and even outdid us in some very important respects.

3 1885

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THE

JOURNAL OF SCIENCE.

NOVEMBER, 1885.

I. THE INTERBOND OF THE SEEN AND THE UNSEEN.

Collated by the AUTHOR OF "SCIENTIFIC MATERIALISM."

(Continued from page 579.)

> "There are more things in heaven and earth, Horatio, than are dreamt of in your philosophy."—*Hamlet.*

"I WILL now illustrate the connection between the internal through the organisation with the external,—*i.e.*, what the mind is dependent upon to generate ideas." Forms reflect upon the mind, which reflection is the *idea*. Sounds convey a peculiar vibration, which undulates that portion of the mind with which they come in contact. "This vibration is the idea." Words are the agents of ideas. "The idea once created is irrevocable, and association of the mind with the form external excites and developes the idea first established." Hence learning is a frequent repetition of the association of ideas, "and thus confirms the knowledge through the faculty, or medium termed association, or imitation." All ideas are dependent on exciting causes; yet every thought is an unrestrained production of a mind acted upon by forms, reflections, sounds, associations, or imitation, "and may be termed irresistible impressions." The cause is invisible; it is not the forms, &c., which produce, but the impression which they produce upon the mind. "There is, *first*, the cause;

secondly, the effect produced; and *thirdly*, the thought or idea, or ultimate. *Thought* is dependent; mind is *independent*, not existing with the body as a component part of its constitution, but is an ultimate of organisation; and *thought* is an ultimate of both."

An idea or thought could not be produced without a mind previously existing. The mind would not be *individualised* without the previous existence of the physical organisation; the organisation could not be constituted without its previous and eternal elementary existence; and all this could not exist without a self-existent, unchangeable, and eternal principle. Thus "the visible and external are *effects* and *ultimates* of *invisible*, yet real, producing causes."

When under impression as to his mind Mr. Davis says:— "When the mind becomes free from the organisation it passes into a new sphere of existence. Impressions of Truth, of Virtue, of principles which govern and control and actuate tangible and physical substances, all converge to one focus: this I call the Fountain, the Sun, the Great Illuminator, the unchangeable eternal POSITIVE MIND. This is the great *Positive* Power; all subordinate existence is *negative*. Both positive and negative exist as a united unchangeable principle of all action. Then as an illustration let the mind conceive a wheel, sphere, or circle, and let it be concentrated at the centre of this, and it will be perceived that there is an expansion of circles from the centre to the circumference, or that one wheel cannot exist without another, and so with the Great Positive and Negative, which compose one whole Sphere of Existence. If these two forces produce all existence, do they not from the centre expand to the circumference, passing through mute and modified forms, until they pervade the Universe and constitute the power of all things?" From this Focus I receive impressions, and "become associated with the spheres of the persons or forms with which it is the previous desire to associate. I do not pass the focus of *all* existence, but to the focus of *this* existence." "When I pass from the body . . . it is the transition or metamorphosis of the principle of mind to its second sphere of existence."

"The focus of this existence is but an indefinite expansion of the Great Focus passing from general positive to general negative existence." "To this centre, to this focus," "I go to receive information. As the mind generates thought by coming in contact with external exciting causes in the natural body, so this Mind (the general mind of the second sphere) creates in my mind parallel ideas I term *impressions.*" Through "the existing medium between the mind and the body I arrive back to convey impressions through the natural organisation."

The ultimate perfection of all substances, the ethereal existence of the spiritual spheres, and the means of impression are evident to me, but so different from the conceptions of the natural mind that it is impossible for me to make them evident to the senses of others. As to my impressions:—

"The human organisation appears as a perfection and combination of all substances below its exalted composition. It is controlled by mechanical and chemical forces, and is a coating, a casement to contain its inward properties. There is another distinct principle which appears, and is evident to me as *Spirit;* also there is a *mediator,* or *medium,* connecting the spirit with the body. The mediator I know as *sensation:* when this medium becomes disunited there is a physical dissolution, and a spiritual elevation to a different sphere of existence. When the mind becomes connected with *this* sphere by a medium similar to that which connects it with the body, it then becomes identified with a personal sphere peculiar to itself."

Man possesses his organs as instruments for external communications, and when transferred (*i.e.,* dies) he retains all the senses in a spiritual condition, and thus becomes susceptible of all properties and elements that compose the existence of all things. The natural organisation perceives appearances as artificial; the spiritual organisation perceives the real and invisible through a sensation peculiarly belonging to its nature.

When in the clairvoyant state the impressions are a knowledge of the *reality* (or essence) of that I desire to investigate without counsellor or informer. All natural things appear closed from view as by a great shade or mantle; all appears one broad and extensive light passing through all the second sphere of existence: the light is the medium of perception and association, and unites them; the reality, the invisible, the real cause of all effects are then known, and this knowledge makes us free.

The laws which govern Nature are established by one Great Positive Power and Mind, and equalled by a negative or ultimate equilibrium. Every particle of matter possesses the same power which governs the whole Universe, and in each particle is seen a representation and evidence of these Divine laws. "Thus in the stone you may see the properties of the soil; in the soil, the properties of the plant; in the plant, the properties of an animal; in an animal you see man; and in man you cannot *see*, but you can *feel* the immortal principle." The unshackled spirit should be considered as the essential principle belonging to the organisation which can cognize instantaneously all things desired, and with its spiritual senses communicate with spiritual substances. I do not receive impressions from the Great Supreme Mind, but from this second sphere, which legitimately belongs to *this Globe alone.* My information is the result of a *Law* of truth emanating from the Great Positive Mind pervading all spheres of existence.

No "one can voluntarily enter that state in which he can view with clearness things belonging to a sphere of existence higher than the natural world." If such were, death would be inevitable. A medium of connection is required, or the mind could not return, and therefore "it is impossible to go *voluntarily* into the *independent* state of clairvoyance without destroying it." "Mathematically speaking, *two feet* from where I now sit is as much in the future state as any other distance. This consists simply in the *condition* which the mind assumes, and not necessarily in any change of its *location*.

In analysing a substance I separate its constituents until I find its simple elements. By a process of spiritual analysis I obtain truth, and pass from the body with a desire for particular information. This attracts the particular kind of truth of which I would be informed, separates it from all other things, and causes it to flow into the mind. To me all that is known as matter becomes rare and unparticled,—as the ultimate of matter to which is applied the word *spirit*. "Things appear real, to me, which are beyond the reach of the natural organisation, which knows of nothing except what exists in matter and form." All ultimates to me are still *matter*, to you they are spirit. "To make the understanding analogically convinced of the ultimation of matter termed spirit, it is necessary to commence at the beginning of all things formal and rudimental, and trace them evidentially and naturally to their ultimate perfection." "*Natural* things cannot produce *supernatural*: this term is only applied to *effects* where *causes* are not evident."

"It is a law of *matter* to produce its ultimate mind. It is a law of *mind* to produce its corresponding principle *spirit*." The nature of spirit is to progress to knowledge. All forms are correspondents of their inner life, which, working by an undeviating law, produces rudimental sensation in the organic system, and becomes a part of animal existence. "So, tracing the refinement of matter from vegetable existence (the life or soul of plants being perfected to become animal sensation), the refinement and perfection of these two to become the substance of mind,—and the progression of its nature to its second sphere and investiture,"—you arrive "at a positively individualised condition, and existence of mind in its first ultimate state of progression."

"There is no such thing existing as positive inertia in matter. If such did exist, man then possesses the power to create; but if there be no such thing, then man has merely the power of developing."

Stones develop like other forms in Nature, as shown by the appearance on their surfaces of decomposition and decay. Where decomposition takes place, re-composition must also have place; for matter is indestructible,—therefore rocks give particles to and take them from other bodies. "There is a constant and undeviating action which produces and reproduces all forms visible and external. Composition, decomposition, re-composition, visible and invisible," perform their natural and ceaseless work; "hence there is a ceaseless chain of formation and reproduction." Thus in Nature every particle of matter, being governed by its law, produces harmony and union in all parts of existence; with an undeviating tendency each particle occupies its destined spot, there to form what is required of it.

The motive power of all life and activity in Nature must be a part of it, because it cannot act separately from it. Motion is there, co-existent, co-essential, and co-eternal with Nature. What is known as motion is not properly life, for motion exists where life does not. The accumulation of particles from combined elements in the interior of the earth form ore, progressing to metal, which then possesses no visible motion nor activity, but time will develop its slow and perfect action, rust accumulates on its surfaces, and finally the whole becomes dissolved and disunited: this illustrates the steady motion existing as an invisible reality.

Peculiar kinds of earths become minerals: at a long interval of progression earths and minerals associate, and form vegetable existence; so, by progressive refinements, particles of mineral and vegetable kingdoms "are rendered capable of becoming the substance of *animal organisation*."

In grosser matter there is contained the primitive and essential principle of motion, yet no combination of numbers could express the periods of years intervening between the first rudimental stages of matter and the formation of minerals. Then is drawn a picture of a person contemplating the advent of life on Earth—life as a new development of the law of motion: the progression of life would be gradual until man was reached, his physical organisation being but an ultimate of matter, an effect produced by an invisible yet eternal cause. Man is now one among millions of forms apparently self-existing, and isolated from the great mass of universal progression.

Man possesses more than life and sensation, and for want of capacity (*i.e.*, want of a higher sphere whereby can be associated that which belongs to this) a conclusion is drawn that because Motion, Life, Sensation, and Intelligence are existing in one form, a theory is sanctioned that Intelligence results from organisation; hence, in the investigation of man's composition, erroneously the conclusion is arrived at that the principle of mind is eternal, yet not individualised. No substance has the power, whether it be physical or intellectual, of self-comprehension. Grosser substances can be traced to the formation of Man, and then Mind, Intelligence, *Spirit*: although all below is correctly comprehended, here there is a confusion, too much belief or unbelief,—the natural consequence of a principle attempting to investigate itself.

It is necessary to understand the classification of Series, Degrees, and Representations, in order that Nature and her co-existent laws may be comprehended—a focus formed of nebulous matter; in other words, a centre produced by a conglomeration of particles must of necessity be a body crude and heterogeneous, yet a *cause*,—the inherent principle in *Matter* known as *Motion*, is co-existent with it. "Such an incipient formation is the only basis on which can rest a proper understanding of the potency of matter and the excellency of ultimates." The correspondential reasoning is based on "the Cause, which is perpetually producing ends and effects."

"There is an invisible Cause producing spontaneously external Effects: these may be divided into *series*, *degrees*, and *representations*. At first Motion and Matter existed: these formed one series. Vegetable production and its . . . developments, and accompanying life, are a *second* form and degree. Animal organisation is a *third* development, or an ultimate, or inward or first cause; its kingdom is a *third* form or degree. The whole forming three series:—*First*, Matter spontaneously producing and reproducing ends or ultimates. *Secondly*, Motion . . . developed into forms suitable as agents and perfect as ultimates to develop its inward principle to the external sphere." "Thus, *first*, matter; *second*, perfect vegetable existence; *third*, matter in animal organisation as its highest state." "There are three *series* or *degrees*. *Thirdly*, Motion as a co-existent principle with Matter, Life as an effect, and Sensation as an ultimate or end; constituting three series or degrees of the progression of matter and its inherent motion."

Then follows an illustration derived from the pathology of the human body (*vide* pp. 66 to 69).

"There is no such thing as absolute *creation;* what is termed such is merely a development of inherent principles which are eternally established and sustained." "Admit that Man is a link (manifest to the senses) in the great chain of correspondences, and then belief will be reposed in the one great power which is governing and controlling all things, and has established a law equal to its own comprehension."

Of the motions which are developed in Nature, and which act on geometrical and mechanical principles, and vary as to the forms and circumstances of their outer manifestations, there is the *rectilinear*, which progresses to the *spiral;* the *curvilinear* was next developed, and other motions legitimately followed, as vibratory, undulatory, eccentric, and spiral or ultimate motions. The first motion contained the specific properties and forces of all the others, produced by and according with the law of universal energy. Thus it is established that matter contains within itself an eternal law of progressive activity,—also a corresponding law of life and action existing individually and essentially with matter; the whole containing forces and materials to produce in future developments all forms and substances in existence. The whole is composed of parts, they being necessary to compose the whole; the whole is a vast machine operating unceasingly by an inherent principle of perpetual action. The whole a *mechanical operation* developing each principle and force, each object and form known to the senses, and governed by the principle known as the *Law of Nature*. So far scientific investigation leads to this conclusion: pause cannot be made here, but further search is made for the *First Cause*. An inductive mind will observe the indications which all Nature presents as pointing to the *Great First Cause, or Positive Mind*. Upon such a basis the mind will rest satisfied: the search to find a cause *still* ulterior is absurd, and even beyond the powers of conception.

On such foundation the mind contemplates Nature producing grand effects in infinite progression, and cannot fail to perceive the adaptation of means to an end as displaying *proof of design*. The cause of all things lies deeply behind all external appearances. Thus a sure basis is given whereon to test the hopes of the future. A future life is proved, making it sure and eternal as the laws which govern the Universe. It is not the object at this time to prove its *how* and *what*, but that it *shall* be. Presently I shall trace generally and particularly, from the Great Positive Mind, the Cause, Effect, and Ultimate of all things; and this will exhibit the infinite progression of all particles in existence, and show that this progression developes the principle so long involved in obscurity, *viz.*, SPIRIT.

The original cause was Nature as a means to produce its ultimate, *Spirit*,—which must be individualised to establish communion and sympathy between the Creator and the thing created, for the Spirit progresses to the source from whence it came, and then only becomes fitted for new spheres of its eternal existence.

By palætiological facts* it is proved that the substance or essential principle becomes *individualised* when Man is made the instrument, and by such individualisation it becomes the future and corresponding principle, Spirit. Matter contains the essence and properties to produce Man as a progressive ultimate, so Motion contains the properties to produce Life and Sensation; these together, perfectly organised, develop the principle, Spirit, not as a consequent of the organisation, but as the result of the combination of all the elements and properties of which the organisation is composed. Such principle (Spirit) must have existed eternally as emanating from the Great Source and Fountain of Intelligence.

Man developes from the germ, until finally the original cause developes, in his maturer condition, the principle of *spiritual life*, whilst he, again as a material substance, reproduces his like, and thus he forms one circle of united action.

The geologist, investigating strata, finds the remains of "Mollusca, Radiata, Articulata, Vertebrata (forms and animals existing, which were successively and gradually developed, accompanying the formations of rock in which they . . . are found), each form a successive link of the forms produced." "At each geological epoch there are seen corresponding productions of the Vegetable and Animal Kingdoms."

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* Palætiological is explained by Mr. Fishbough to come from *palaios*, old or former, *aitia*, a cause, and *logos*, a discourse. Palætiological sciences are those sciences *formerly* established which conspire in the formation of a cause or foundation from which other conclusions may be developed. The word claims Geology, Anatomy, Physiology, &c., forming proofs of the united chain of existences.

"The *atmosphere* which surrounds this Globe has corresponding strata of formations, each holding a position in rotation to the Earth according to its specific gravity. The Earth possesses an attractive power over the same, the influence of which counteracts its expansive force, and prevents the formation of an atmospheric connection with other earths in existence ; each stratum exerts a pressure on that which is beneath it, and the whole produces a weight which is confining every particle or substance existing upon the surface of the Earth."

Nature must of necessity, according to an Eternal law, operate as an effect or secondary cause to produce higher and more perfect spheres of material existence. "It was the object for the Earth gradually to progress in its material perfection, to produce plants, animals, man. It is also the object for Motion, Life, and Sensation to combine with the perfection of the former to produce the principle of *inner life*. . . . So the First or Great Positive Mind operates as a Cause, through Nature as an Effect, to produce Spirit as an Ultimate."

"Is there not an internal and external evidence of this which transcends words to express thought ? Are there not inward convictions dwelling in the mind corresponding to its desires for a future and eternal state ? Does not the *internal* constitute the *substance* of the external ? Does not Nature as an *external* effect point deeply and indirectly to the *internal* or fountain of its original production ? Do not the inseparable truths which each science unfolds . . . terminate in one common focus ?"

All this evidence is contained in the physical organisation of man, yet, owing to his sphere of existence, the subject of a future life cannot be demonstrated to his senses. Man contemplates Nature and her laws as eternally and invisibly producing results according to their inherent qualities and forces. The highest and most important subject to comprehend is the inward reality which constitutes the ultimate existence of the contemplator.

The *Uniformitarian* system of Geology, by internal and external evidence, demonstrates its truthfulness. In various parts of the Earth strata have been deposited which are absent in other parts. Nature in a *particular* sense has manifestations of catastrophic events, yet in a *general* sense there is a manifestation of steady and universal formation. The anatomy of the Animal Kingdom teaches an important truth—"*original and eternal design.*" From the considerations of Cosmic relations and phenomenal display a conviction is produced in the mind that there is an inherent and necessarily intelligent Principle existing, because a contemplation of the whole discloses a united chain of harmonious development displaying order and progression,—all of which must be conceded as the production of the *Great* Positive Mind.

Mechanical principles constitute the united actions and forces of Nature; and here only can the mechanic receive instruction, for do what he will he can only develop the principles contained in them.

"Reasoning from the established axiom that there must be a *Beginning* or a First Cause to produce corresponding ones, it follows that either *Matter* has existed from all eternity or else the essence of an *Intelligent* First Cause. One or other of these conclusions must of necessity be drawn from the indications which all external substances and forms present. The idea is indisputable that *something* must have *originally* existed to produce that which does now *exist.*. That matter and motion must have existed independently, or that the Great Cause must have been the *Productor* of that which does exist. The mind is therefore led back from effect to cause, until it conceives of the *First* Cause, or rather is compelled to admit the existence of such."

The sum of the arguments, for many pages, shifted and changed in all manner of ways, and an almost endless repetition of that which has gone before (yet all conveys to the reader a feeling of astonishment that such enunciations should have prcceeded from an unlettered boy), is that the whole Cosmos was designed to individualise Intelligence, from which Individualisation is manifested Spirit; that the creation of the whole Universe was for this end, and that each change, inorganic and organic, was but a progressive step; that all the facts of Nature show design; that the Great Positive Mind is eternal; that Matter, the product used for its purposes, is also eternal—because of its origin; so Man, its ultimate as Intelligence or Spirit, is also eternal.

He claims to have proved an *Intelligent First Cause,* "and the positive individualisation of the inner life or *spiritual principle.*

N.B.—The Key (this part of the work) was delivered from the *second sphere.* In the delivery of the following work he ascends gradually to the seventh sphere : the *How, What,* and *Shall* is then to be explained.

(To be continued.)

II. A THEORY OF THE ACTION OF CHEMICAL FORCES.

ATOMICITY is considered by Mendelejeff to increase from the beginning to the end of the septenary series ; but it is seen that this is apparent rather than real if we examine the illustrations advanced in support of this view.

First cycle (oxides)—

(Li_2O) G_2O_2 B_2O_3 C_2O_4 N_2O_5

Second cycle (oxides)—

Na_2O Mg_2O_2 Al_2O_3 Si_2O_4 P_2O_5 S_2O_6 Cl_2O_7

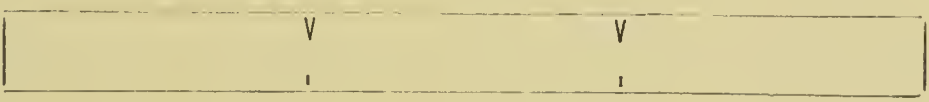
In the above table the succeeding elements in each of the two simple cycles combine successively with one, two, three, four atoms of oxygen, and upwards ; and since the atomicity of oxygen is two, an element which combines with one atom of oxygen would seem to be a dyad, an atom which combines with two atoms of oxygen to be a tetrad, and so on. But while the first elements in each cycle are strongly positive, and produce oxides of a basic character, the last elements are negative, and their oxides are acid-producing bodies. And only in the middle of each cycle do the elements form oxides which are approximately indifferent or neutral in character. Oxygen is itself negative, and when combined with positive elements its effect is to neutralise to some extent their positive properties. Thus the oxides of the alkali and alkaline earth metals are powerful bases, while their peroxides are unsalifiable. When the element is of feeble polarity the oxygen determines a slight preponderance of negative properties in the compound, as in the case of silicic oxide. When combined with negative elements the negative character of the oxygen is superadded to the negativity of the negative elements. At the same time the stability of the union decreases as the negativity of the element becomes more pronounced. The oxides of sulphur are formed by direct synthesis, and are comparatively stable; the oxides of chlorine are not formed by direct union of the elements, and are decomposed under conditions of slight disturbance. This indicates that the atoms of oxgen in the oxides of chlorine are linked to each other,—evidently a condition of unstable union. The salts formed from these anhydrides are more stable, because the positive element reinforces the feeble polarity of the chain. If we examine the chlorides of the elements we find less evidence of high atomicity in negative atoms; and if we consider those cases where union takes place between mutually attracting elements of opposite character, and produces neutral, stable, substances as the result, we find, on the contrary, that not only do the most negative elements possess low atomicity, but that the progression towards this condition is regular in each cycle. Thus the metal sodium combines with one atom of chlorine, and the metal magnesium with two atoms. The earth metal aluminium combines with three atoms of chlorine, and silicon with four atoms of chlorine or of hydrogen. Phosphorus combines with three atoms of hydrogen, and with three positive atoms by means of intermediate oxygen atoms in the orthophosphates. Sulphur combines with two positive atoms in sodium sulphide, and indirectly with two atoms of sodium in sodium sulphate; and chlorine combines with one positive atom in sodium chloride. And if we confine the conception of atomicity to cases of union of elements resulting in the evolution of heat, in stability of the molecule, and neutrality, caused by satisfied affinity, we find it everywhere to be highest in the middle of the cycle. In the middle of the cycle, also, we find the minimum of atomic volume, and the occurrence of the properties which seem to depend upon proximity of atoms, *viz.*, high melting-point, rigidity, and minimum expansion by heat, and that these properties of matter always occur simultaneously with high atomicity is evidence of the existence of a common cause of the phenomena.

The attraction between atoms, which brings about chemical union and the formation of the molecules of compounds, in some respects resembles electric and magnetic attraction; it is greater between two atoms when one is more strongly positive and the other more strongly negative. Cohesion, that is, the force which controls the distance separating atoms in the liquid and solid condition, resembles gravitation in not exercising this selective attraction, but differs from it in taking place only through small intervals of space. The same difference also distinguishes chemical action proper from electric and magnetic attraction. Although chemical action proper and cohesion thus differ so widely, it is possible that the same causes which produce the one produce the other. For cohesion is greatest where the atom has the power of uniting with the greatest number of atoms of opposite character, and least where the atom is a monad.

We can imagine that these two attractions are the results of the action of elements of force, which we may call *chemical poles*. The *pole* is the immaterial counterpart of the atom. Each is minute, indivisible; the atom is the unit of matter, the pole the unit of chemical force. A pole is indivisible, and cannot coalesce with any other pole, although there can be mutual inductive action between them. This mutual action resembles the induction which takes place between magnets and between electrified bodies. Poles differ in kind, being negative and positive, and chemical action proper is the result of the attraction between pairs of poles, of opposite character, or at least of unequal intensity, each pole attracting only its fellow in the pair. Cohesion, on the other hand, is the result of the general attractive action of poles, the influence of each being diffused over all other poles within the range of its power. A monad atom is the *locale* of a single pole, which dominates it. A dyad atom is possessed of two poles, each of which acts individually upon outside atoms, and exerts an inductive action upon its fellow in the same atom. The inductive action lessens the power of each pole, and hence chemical affinity is less intense than in the monad atom. In the same manner a triad atom is the seat of three poles, each less intense than either of the poles of the dyad atom in the same cycle. But the sum of the general diffusive attractions of the three poles is greater than the sum of the general diffusive attractions of the two poles in the dyad; therefore the atomic volume of the triad is less than the atomic volume of the dyad. And since the poles are links binding all adjacent atoms to one another, the resistance to the dissolving tendency of heat increases with the number of poles. A dyad therefore melts at a higher temperature than a monad, and a triad at a higher temperature than a dyad. The same increment of heat causes less expansion where each atom has a number of poles than when the poles are few: the vibratory movements constituting heat and electricity can be more readily communicated from atom to atom when they are near together, but unconstrained by manifold attractions to move within narrow limits.

Chemical force is, in a sense, a polar and dual force. Positive poles attract negative poles, but they do not repel positive poles; on the contrary, they exert an attractive influence of indefinite character upon all positive poles within the range of their power. Chemical poles act inductively, not only upon each other when in the same atom, but upon poles in other atoms. If the intensities of the poles are unequal, but of like kind, the stronger pole induces in the weaker pole an intensity equal to its own, but of opposite kind, and the difference between the induced intensity and the original intensity of the weaker pole is the measure of the affinity between the two poles. Since no two elements have exactly the same affinity it is always possible for them to combine (under proper conditions of temperature, &c.), but the more nearly equal and alike are their affinities the less is the attraction between them.

There is under certain circumstances definite union between atoms of the same element. This arises when the general diffusive attraction of poles, or cohesion, is overcome by heat. In the solid, cohesion of atoms produces rigidity, hardness, elasticity, and the ordinary phenomena of solidity. In the solid, each pole is bound by attraction to a number of other poles, and its motion is confined within a narrow range. As the temperature increases its tendency is to overcome the cohesion of the poles, but one pole has always, by force of position, a greater cohesion for one other pole than for the rest. As the atoms break away from one another the hardness, rigidity, and elasticity of the solid decrease. At a certain stage each atom on an average coheres to two others, to one more strongly than to the other. The solid has then reached the pasty condition immediately preceding liquefaction. As the temperature increases the third atoms begin to break away, being themselves held more powerfully by other atoms; the solid is now melting. Finally, when all the cohering atoms have formed into pairs, each atom of which is free to roll round the other, complete liquidity is attained. The atoms, however, are still sufficiently near together for each pole, as its atom rotates round its fellow, to come temporarily within the sphere of power of other poles, and thus groups of three atoms are being constantly made and broken. This residual attraction of third poles constitutes viscosity, and also keeps the liquid within the narrowest limits. The further addition of heat causes the residual attraction of third atoms to vanish; the pairs of atoms now fly asunder under the influence of impact: the body is a gas. Each of the pairs is a molecule; and the attraction holding the atoms in the molecule together is not chemical attraction proper, as between unlike and unequal poles, but a concentrated remnant of the general diffusive attraction of cohesion which a pole in the solid exerted upon all others within its range of power. The manner in which a solid breaks up into pairs of atoms can be illustrated in a very simple manner. Take a strip of paper a few inches long and of uniform width, and cut partially across the paper in two places, so as to divide it into three equal segments.



However equal in strength the connecting uncut links between the segments may appear, it is impossible to so pull the segments apart that the middle one shall be left free of both the end ones. One of the two is sure to be a little stronger than the other, and the middle segment remains attached to one or other of the end pieces.

The opposite nature of positive and negative poles is seen in the influence which the mass of the atom seems to have upon its affinity. The positive elements of highest atomic weight have the most intense affinity; cæsium is the most active alkali metal, and lithium the least active. Iernium (at. weight about 225) will be more active than cæsium. On the contrary, negative atoms of least weight have the most intense affinity; chlorine is generally more active than bromine, and bromine than iodine.

The exercise of that form of attraction by poles which we have termed chemical attraction proper evidently does not prohibit the attraction of cohesion which each pole can exercise. The cohesive attraction survives after the affinity of the poles is satisfied, otherwise all compounds would be permanent gases. But the ratio of the two attractions is not constant in all poles. Hitherto our illustrations have principally been taken from the first two or simple cycles, and we have seen how closely atomicity and atomic volume are associated in them. All higher cycles are complex, each containing two or more of the primary septenary series, the "octaves" of Newlands. The third and fourth cycles have each two primary series, with three intermediate elements, which latter are the iron group and the first platinoid group respectively. The first member of each of these cycles is an alkali metal; the first members of the second septenary series in each are metals, copper in the third cycle, silver in the fourth, which differ vastly from the alkali metals, but which are held to have some analogies with them. These analogies are due to atomicity. Copper forms compounds in which the metal is a monad, and the only (or almost the only) salts of silver are of this class. Silver and copper, however, are widely different from alkali metals in most other respects, notably in being very inactive chemically, and in having high densities. Evidently, then, the atoms forming the higher cycles have conditions absent from the elements of the simple cycles, which impress upon these cycles their complex character. In the third cycle elements for the first time depart from the primitive order. The first element of each primary series is no longer in all cases an alkali metal, but may be a metal of a new and distinct type. In this new kind of elements the poles are of a second order, in which the ratio between chemical attraction proper and the attraction of cohesion is changed. Chemical attraction is less and cohesion is greater,—hence the characteristic inertness of the atom. Chemical activity is a function of the two forms of attraction, directly of the first, inversely of the second. The first proposition needs no demonstration, and the second is true because the attraction of cohesion must be overcome before union with unlike atoms is possible.

Atoms are subject to periodic modification as a law of their being. There is lithium, and six succeeding elements; then again an alkali metal and six succeeding elements, repeating the type of the first. The cycle advances by *transitions*, the progression being nowhere broken, but always moving regularly from type to type. The third cycle begins with an alkali metal, and its second and third elements closely resemble their lower atom analogues. Afterwards the resemblances are less distinct; the cycle is in transition towards elements of the second order. High atomicity, high melting-point, and low atomic volume culminate in the iron group; and the succeeding element, the first member of the fourth septenary series, has poles of the second order. Chemical activity is least at this point, and density, melting-point, and atomic volume no longer return to the type of the alkali metals. But although there is no recurrence of the former monad type, there is distinct evidence that the fall in atomicity is not without influence. The atomic volume rises, the melting-point falls, and the expansion by heat becomes greater at this point. Copper and its analogues, silver and gold, are in each cycle the elements of least chemical activity, and are by far the best conductors of heat and electricity. Malleability and conductivity are properties possessed by positive elements, and by positive elements of low activity, to a greater extent than by positive elements of high activity. The elements of the intermediate groups preceding copper and its analogues are held together by more poles, and are harder, more brittle, and more rigid; copper and its analogues are held together by poles fewer in number, but of higher cohesive power, and these metals possess more malleability and softness, and are better conductors. The atoms, while strongly cohesive and close together, are more capable of relative motion.

In the elements of the series commencing with copper (silver and gold) the transition proceeds in the opposite direction,—that is, to the occurrence of poles of the first order. Atomicity rises and then falls to the monad halogen type, the change being accompanied in a rise and fall of the melting-point, and by a small but sensible depression in the curve of atomic volumes.

III. "SOLAR LIGHT AND THE EARTH'S ATMOSPHERE."

By the Count O. Reichenbach.

A LECTURE on the above subject was delivered on April 17th, 1885, by Prof. J. P. Langley, at the Royal Institution.

Speaking of his observations during his expedition to Mount Whitney, the lecturer said:—"The results, stated in the broadest way, mean that the Sun is blue; but mean a great deal more than that, this blueness in itself being perhaps a curious fact only, but in what it implies of practical moment."

"We deduce in connection with it a new value of the solar heat, so far altering the old estimates that we now find it capable of melting a shell of ice 60 yards thick, annually, over the whole Earth," &c., "and we have found that the total loss by absorption from the atmosphere is nearly double what has been heretofore supposed."

Pouillet found that solar heat might annually melt 30·87 metres of ice, but that this was not all the heat received from without; he attributed the surplus to space, and made it equivalent to melting 26 m. of ice. He therefore estimated all heat we annually receive from without equal to melting 56·87 m.

Pouillet took 75° C. for the specific heat of ice melting; Prof. Langley, 79·25°. By applying 75° his 54·87 m. increase to 57·7 m. The two observers differ, therefore, not as to the quantity, only as to the sources of heat.

In September, 1882, a volume "On some Properties of the Earth" (1880) was presented to Prof. Langley. The portion specially pointed out to him discusses the papers of Pouillet. The quotation of a few passages sufficiently tells the result of the discussion.

Page 167.—"Apart from other considerations the 30·87 m. are slightly in default, because based on r, not on $r+h$, &c., as e is not $= o$."

Page 175.—"Pouillet finds that solar heat could annually melt an ice-crust of 31·34 m. all over the Earth; but as each point of its surface is in the mean only exposed half the day to this action, the heat which enters by it will possess double the energy calculated, or that of—

$$6·44^\circ \times 2 = 12·88.$$

He also saw that a larger quantity of heat than 6·44° daily must be received from without by any one square centimetre, or, putting it differently, by any one point of the Earth; and he saw the source of this heat in space, and calculated its energy equal to melting 26 m. of ice."

"He does not claim absolute correctness for his 26 m., which are to 31·34 m. as 5·22° : 6·44°. I intend to show that this heat is also solar, and is starting from the limits of the atmosphere also equivalent to 6·44°, or 6·55° considering refraction. If I be right, the effect exercised on any point of the Earth at the limits of the atmosphere will be in the mean of the day equivalent to—

$$6·44^\circ \times 2 = 12·88^\circ,$$

and the energy with which it acts on such point, the Sun shining only for twelve hours on any point, will be—

$$6{\cdot}44^\circ \times 4 = 25{\cdot}76^\circ."$$

Page 179.—"The effect of the Sun on any one point during twelve hours will be therefore equivalent to melting an ice-crust 31·34 × 2 m. thick, over the whole earth."

Page 180.—"But why did Pouillet, starting from a false premiss, obtain an almost correct, or a correct, result? for we have only to add to his 26 m., almost corresponding to to 5·22° received at the surface of the real Earth, in which he erroneously thought he had included the air, the 1·22° from the limits of the air to the surface of the Earth to get the second 31·34 m. complete, corresponding to the 6·44° at its limits."

It is sufficient to say that, by an interpretation of Pouillet's observations different from his, put to the proof by analysing the work performed by the Sun, I made the Sun's heat effect equivalent to melting an ice-sheet 62·68 m. thick,—more still than the 57·7 of Prof. Langley, who did not observe at the limits of the atmosphere.

IV. PHYSIOLOGY AND ITS OPPONENTS.*

(Continued from page 603.)

MR. ROBERTSON then goes into the question of legislation for restraining cruelty to animals. He holds that in so doing "we deliberately interfere with the liberty of our fellows, and that by way of asserting not the rights of animals, but our own; for we do not claim for the hurt beast our own right of freedom,—we simply assert our determination to protect our own sensibilities in a case where we are convinced that the wounding of them

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* Apologia or explanation of my last Article on Vivisection which appeared in a London Journal, September, 1, 1884. By a "WEAK WOMAN" who withholds her name.

The Ethics of Vivisection. By J. ROBERTSON. From "Our Corner." August 1, 1885.

(our sensibilities) implies an anti-social tendency in the aggressor. The discerning reader perceives, no doubt, that this is the form of argument used to support the blasphemy and Sabbatarian laws, and religious persecution generally." Still Mr. Robertson holds that "the prevention of cruelty by Law is about as safe, and stands on the same moral footing, as the prohibition of indecency." But the whole of this acute argument is really beside the question. For what is cruelty? Not the infliction of pain *per se*, but its infliction out of carelessness, for amusement, or for revenge. The most uncompromising opponents of the Bestiarian hubbub, ourselves included, would most willingly restrain every infliction of unnecessary injury on animals or plants.

Says Mr. Robertson—"We now come to the practical issue. Shall vivisection for purposes of medical research be suppressed on the score that the practice is demoralising whether useful or not; or shall we remove the restrictions at present laid on it?" We distinctly deny that the practice is demoralising. Both the men who engage personally in experimentation on living subjects and those who analyse and co-ordinate the results obtained may boldly challenge a comparison of their lives and characters with the most squeamish sentimentalist. To the outside public it cannot be demoralising simply because it is not, or rather was not, known. If it has *now* any demoralising effect upon the public—which we do not believe—the blame rests on the Bestiarians themselves.

Mr. Robertson continues:—"Those of us who have no fixed prejudice against legislation, as such, can see that there is a good deal to be said for the present arrangement of licenses, which puts a check on mere experiments in torture, and leaves a possibility of conscientious research." Here Mr. Robertson is doubly in error. Anyone who wishes to indulge in torture can do so with utter impunity at least on wild animals, provided he assigns as his motive "sport" or a wager. And the "possibility of conscientious research" is, on the other hand, extremely slender. If we consider that the applicant must first obtain a recommendation from either the President of the Royal Society or from the heads of our chief medical bodies, and then forward this document along with his application to the Home Secretary,—an overworked official, who as a rule has scant sympathy with Science,—we cannot fail to see that for an obscure uninfluential man to obtain a license is simply out of the question. But even men of known standing are often enough brought to a deadlock by this lamentable Act. As "Philanthropos" tells us, "Dr. Brunton has been forbidden to seek for antidotes to snake-bites. Prof. Fraser has been checked in his attempts to study the nature of the poison used by the natives of Borneo upon their arrows; while Prof. Lister has had to leave England in order to carry on his researches." We have heard of a case where certain eminent medical men, wishing to study the poison of serpents, imported some very formidable specimens, and applied for a license; but before the necessary red tape was reeled off the snakes died. How many important inquiries are never undertaken in consequence of this Act cannot even be conjectured.

Mr. Robertson writes:—"At this moment a hundred forms of cruelty in the shape of 'sport' and the poisoning of vermin are not even menaced by Law; and Miss Cobbe admits that sportsmen are to be found among those who demand the suppression of vivisection. What we do is to put a rigorous check on the one form of systematic tampering with animal life which can be pursued from respectable or disinterested motive, and, instead of impartially proposing to extend this check to the less defensible forms, the Bestiarians simply clamour against the check as being a sanction. There could not be a more flagrantly nefarious tactic. . . . A benevolent passion is, in itself, no safer guide than passion of any other kind. At best the emotionalist has to rely on stress of language rather than ratiocinative persuasion, and at the worst the desired effect is compassed by *fearless fabrication.* Prof. Huxley is said to have complained of the 'profligate lying of virtuous women' in this connection, and I can testify to having seen and heard some of the lying from both sexes. I have heard one lady allege, in a semi-public meeting, that the Professor had declared animals to be automata who do not feel; and on challenge she could give no reference save a general one, which made it practically certain that she was simply misrepresenting his Belfast Address, in which he maintained the thesis that men and animals are alike automata, thus leaving the question of their comparative capacity for pain just as it stood before; and in which besides he expressly said—benevolently rather than logically—that he was strengthened in his rejection of the extreme Cartesian view by the recognition that it might encourage cruel treatment of animals."

A distinguished American contemporary regrets that the British "public did not and does not know enough about the matter to save itself from being misled by the reckless misstatements of irresponsible fanatics, and of certain seekers after notoriety or salary"; and further, that "it has been possible for certain anti-vivisectors, by a persistent course of malignant vituperation and brazen mendacity, to produce a widespread belief," &c.

Of course if we were to give one-half the cases where Bestiarian advocates have dealt in untruths, ranging from exaggeration, *suppressio veri*, false insinuation, garbled quotation, &c., down to direct, intentional, and conscious falsehood, a monthly number of the "Journal of Science" would not suffice. The leaders of the "movement" well know that if they only persist in throwing dirt, some of it will stick. They know, too, that a false accusation may be made in very few words, whilst its refutation, requiring more, is less likely to be read. They have developed a fertility in deceit from which—even if Jesuitism were all that ultra-Protestant fancy pictures it—the wiliest Jesuit might learn much. But a couple of the most flagrant instances must be quoted. There is in Germany a certain Herr von Weber, who is the head of the Bestiarian movement in Germany. This Weber, a "Knight of high orders," as he styles himself, has written a book entitled the "Torture-Chambers of Science." In this he asserts (edit. 5, pp. 11 and 26) that Prof. Goltz did not make use of anæsthetics in his researches on dogs,—experiments which the Professor has described in a special work. Now in the Introduction to that work it is expressly stated that all the animals operated upon were, before the commencement of the experiment, brought thoroughly under the influence of chloroform! Weber cannot escape by pleading ignorance,—though that would be no legitimate excuse, since his work, the "Torture-Chambers," supplies abundant evidence that he has carefully studied the writings of Prof. Goltz. (See Prof. Goltz's "Rechtfertigung eines Vivisectors." Strassburg: K. J. Trübner.)

Hardened by practice, Weber went on to accuse a physician of having vivisected a man. This case was brought before the Courts, and Weber was condemned to imprisonment for libellous falsehood. His accomplice, the editor of a German Bestiarian organ, shared the same fate. These be the gods of Bestiarianism!

The Bestiarians have also falsely claimed Darwin, Cuvier, Bell, and Hyrtl as authorities on their side. In refutation we must refer to Darwin's letter to Prof. Holmgren, to Cuvier's *éloge* of Flourens, and to the works of Bell and Hyrtl. In short, mendacity may be pronounced the warp, and ignorance and the love of ignorance the weft, of the Anti-Vivisection Movement.

But to return to Mr. Robertson. He continues:—" Between such indulgences in reckless slander and the blunders into which they fall through extreme ignorance the defenders of the 'rights' of animals make a rather sorry exhibition. Miss Cobbe has been so egregiously absurd as to call a 'reflex action' a 'spasm of agony,' not knowing [or knowing but not caring to admit?] that the *sine qua non* of the thing is the absence of sensation in the subject; and the Scottish Anti-Vivisection Society, a year or two ago, made a vehement attack on a Professor for the cruelty of certain experiments in which he had pointed out there was no pain at all. Anyone with the merest smattering of physiological knowledge would have known as much from the reports; but the superfluously sympathetic zoophiles conceived a decapitated frog and an amputated frog's leg as writhing in agony under the hands of the demonstrator. We see, then, that an excessive sympathy with animals is not at all necessarily an elevating influence, but may, like every other unregulated emotion, lead to all sorts of harmful conduct. What does the extreme attachment to animals, seen in so many anti-vivisectionists, really signify? Obviously a faculty for taking an extremely idealised, and therefore false, view of an animal's nature; for misconceiving, consequently, the relations of things in general; and for keeping the reasoning faculties in disastrous subjection to the passions. People admit in theory that any personal quality may become a vice merely by running to excess, but they singularly fail to apply the principle in detail. The zoophile flatters himself that his love of animals is a shining virtue, when in point of fact it is an extravagance which warps his moral nature, and makes him unscrupulous towards men in proportion as he is tender towards beasts. Take, further, the conception of the nature of cats and dogs exhibited in Miss Cobbe's pamphlet. There is no word there of the other side of the animal nature; and no recognition of the fact that the fidelity of cats and dogs is practically an unmoralised affection, being simply given to those near them without any save interested discrimination. [The Bill Sykes of fiction and the Peace of real life, along with unnumbered brigands, murderers, tyrants, and fools, are as dear to dogs as if they were saints or sages.] That is the typical attitude of the adorers of pets. . . . The pet-lover is not disturbed by his cat's cruelty to mice or his dog's ferocity towards other animals: these manifestations of character are serenely set down to irresponsible instinct; whilst the show of affection, which is equally a matter of instinct, is called a 'noble moral quality.'

In short, the zoophile's zoophily is mainly egotistic, 'my dog's devotion to me' being taken as the summing up of the dog's relation to life, though sympathy so far operates as to attribute like excellence to other people's dogs."

In good sooth the zoophilists fare but ill under Mr. Robertson's searching analysis. We have yet to examine the Bestiarian version or perversion of the "sport" question.

(To be concluded in our next.)

V. THE "TRADING-RAT."

By Mrs. E. D. W. HATCH.

WHILST borrowing an account of this curious animal from our valued contemporary, "The Popular Science Monthly," we take the liberty of adding certain comments. We do not call in question the facts as narrated by Mrs. Hatch, but we cannot help demurring to the interpretations here put forward.

"THESE interesting rodents are dwellers in the Rocky Mountains and adjacent hills, and are known among us by various significant names, as mountain-rat, timber-rat, and trade-rat. The first, of course, refers to their native home; the second to the sound of their gnawing, scarcely to be distinguished from the sawing of timber; and the last to their peculiar system of barter or exchange, so curious a habit that it is doubtful if any other animal has ever been known to practice it while in a wild or untamed state.

"One of these rats being caught in the house, attracted notice by his size: I measured him, and found his body 8 inches long; tail, 8 inches; around his body, under his fore legs, 7 inches; ears, 1½ inches; fur beautifully fine, grey, with a darker shade, nearly black, running lengthwise down his back. He was very plump and fat, but I omitted taking his weight.

"They haunt houses and camps near the hills, but seldom, if at all, those a few miles away. The peculiar trading characteristics natural to this little merchant, its habit of exchanging goods without a 'by your leave,' wise ways, and queer tricks seem far more like reason than instinct." [We need scarcely remark that we do not accept the common notion of "instinct" as an antithetical substitute for reason.] "A few incidents which came under my own observation will illustrate this characteristic. Some men, passing through the country, camped in a deserted cabin, and, before wrapping themselves in their blankets for the night, they placed their bread for breakfast in a pan near the fire. On rising, to their dismay, not a crumb of bread was left in the pan, but it was filled with old scraps of leather, chips, bones, mouldy beans, rags, &c. Searching, they found, high up on a partly broken shelf, in an old tin can, their bread packed away with old bacon-rinds, bones, rags, and other trash.

"In the house of one of my neighbours these mischiefs carried away a lot of Indian meal, and in the meal-box deposited a quantity of bird-shot, which, mixed with the remaining meal, caused the housekeeper great dissatisfaction. In the same house a trunk was accidentally left open one night: in the morning a quantity of rice, bits of dried fruit, and some oats, were found mixed with loose coral beads and other small trinkets. It was an exercise of patience to separate the articles, as may be readily imagined.

"With these traders exchange is no robbery, and distance small hindrance; they travel from their homes and go from barn to house, from loft to cellar, and through living-rooms (noiseless when acting as porters), with great speed and impartiality. A sheep-herder, returning to his camp from a town 30 miles away, brought home a fine new hat; placing the box on his table, he went away for the night. Returning, he found the box had been entered, the crown of the hat eaten entirely round, and the box then filled with wool, flannel rags, remains of food, wheat, and dried fruits. There was a sudden forced abandonment of that unsurveyed 'squatter's claim.'

"Some ranchmen were gone mowing for several days, camping away from home. After their return they soon learned that their quarters had not been unoccupied during their absence. A nest composed of wool and rags filled the flour-sieve left upon a shelf: next beside the sieve stood the coffee-box; in it had been left about a pound of good coffee; now the box was filled to the top, mixed with the coffee, mouldy crusts, bones, and rinds, that had been scattered about the place. 'When I threw it all out,' said the man, who was telling me, 'provoked as I was, I could not help noticing how *prettily* the nest was made up of gnawings of an old blue army-overcoat, red flannel shirt, and many white rags, put together so nicely and made so soft within.' This morning, going to the store-house for a lamp-chimney, I found an ordinary glass chimney packed close with straw, grains of rice, oats, wheat, a few beans, and chips.

"The mischief these rats can do in a single night is almost incredible. One, getting into a lady's room, stripped her house-plants of every leaf and blossom, and hid himself behind the wardrobe, where he was found next day, with a most singular accumulation of goods,—among them many bits of paper, a quantity of raisins, a box of matches, some candle-ends, gnawed postage-stamps, and a lot of odds and ends. Nothing seems to come amiss, and they are particularly fascinated by anything that glitters, often carrying off knives, spoons, watches, and silver, and hiding them effectually.

"They are 'good providers,' and in the fall build their nests, and fill them with stores of eatables, the result of persevering foraging expeditions for their families before winter sets in. Under a large cotton wood-tree on a side-hill, partly underneath a fallen trunk, a party of us found a mountain-rat's nest. It was built up nearly 2 feet in height, the top or roof covering it sloped on all sides to shed rain or snow: tearing it to pieces, we found it was built closely of grass, moss, chips, bones, and many leaves of the cactus (which grows plentifully among the rocks); how they could cut off and convey this thorny stuff, working it up with the other material, in the close covering, is hard to understand. Away down, running in almost under the log so well built around, out of the reach of any possible moisture or cold, a clever little bed of wool was found, made for the young rats. This wool, of which there was a quantity, must have been collected bit by bit from the weeds through which the sheep passed, and from their corrals.

"To reach this nest in the rat's house there was quite a long, circuitous passage, entrance close to the ground, on the south side,—a little den or hole to crawl through. In a little heap outside, not yet carried in among their provisions, but lying close by, we found more than a quart of fine fresh-looking potatoes, brought from our own garden; and it is an unsolved mystery how the potatoes were taken there, with not a scratch or mar upon them, or the skin bruised or broken. The garden was a hundred feet away, considerably lower down, and a stream of water, an irrigating ditch, to be crossed to reach it. One person suggested that the rats might have rolled them all the way, and across some poles thrown over the stream.

"Destroying this nest, a couple of rats darted up the standing tree, and there we were surprised to find another nest had been commenced in the forks of the tree. We destroyed this nest also; but here comes in another mystery, a puzzling question—How could the rats climb that tree and carry up stores for the winter? This nest was probably 25 or 30 feet from the ground.

"I asked a ranchman a few days ago, who was talking about them, if he was afraid of them (I meant of their bite). 'No,' said he, 'and they are not afraid of me; they have waked me many a time, sitting up on the floor of my cabin and rapping their tails like a dog!'"

Mrs. Hatch adds:—"I have already spoken of their great strength and celerity of movements. To an observer these traits are a never-failing surprise. If a light is steadily burning, and all is quiet, they are easily watched, darting backwards and forwards, carrying goods each way, and often making long trips. I have known them to bring nails, bits of iron, screws, and other things left about the sheds, to the house from some distance, placing them on shelves, boxes, or kegs, just as they fancied, but all in some selected spot, carrying back from cellar and store-house dried prunes, apples, rice, and all kinds of eatables. If working in the dark the striking of a match, a slight noise, or a sudden light will cause them to vanish like a flash.

"They seem, too, to have a fancy for certain colours, particularly bright red, and will soon make away with garments of this colour and attach them to their nests. There may be something attractive in the dye, but, knowing their partiality for glittering, shining objects, I am inclined to think that they have also an eye for colour."

We must now endeavour, in examining this account, to distinguish between fact and inference. We may premise that we should gladly welcome the demonstration, in any species of the lower animals, of the idea of exchange,—that of property, real and personal, is indisputably manifest in several.

The facts really before us are that these "trading-rats" have been found, in many instances, to bring as well as to take away. If they take certain articles from a given place, A, to another, B, they are described as bringing to A other articles, either from B or from some other place.

Here the question first arises, Do they never take without bringing, or bring without taking? Upon this point Mrs. Hatch does not throw any decisive light. But she mentions that the rats had conveyed away from her garden a quart of potatoes, and left them near their nest 100 feet away. Had they brought anything in return? But the main question is, Do these creatures at all conceive that they are making any return for what they carry off? After very carefully reading the narrative, we must confess we can see no evidence to that effect. Their operations, as here narrated, seem mainly to consist in displacing articles already existing on the premises. Now this displacement, or in human eyes *mis*-placement, is certainly not peculiar to the rat in question. It is observed in other Muridæ. Years ago we were much annoyed by the conduct of the grey or Russian rat in this way. We were conducting some experiments in a chemical works in the country, and found that the laboratory and the offices swarmed with rats. One morning we found that several sheets of filter-paper had been taken away from an ill-made drawer in which it was kept; that much of the remainder was torn, greasy, and generally dirty, and that there was a quantity of palm-oil deposited in the drawer. This oil had been taken from a cask in a store-room a few yards from the laboratory, and thither a part of the filter-paper had been conveyed. Their motive for carrying off the filter-paper is not hard to trace; but why they should have brought the palm-oil, which they could have nibbled just as well in the store as in the paper-drawer, no one could conjecture. We have further heard of, and even seen, other instances where mice or rats have deposited, in nooks and corners, rubbish of various kinds, not suitable either for food or for lining their nests. The only motive we can imagine for such actions is a propensity for "meddling and muddling," and this view seems to suit very well the cases narrated by Mrs. Hatch.

From a human point of view these "trading-rats" must be counted a most serious nuisance, since they not merely plunder, as do monkeys, cats, magpies, ants, and other creatures, but by their exchange transactions they spoil more than they carry off. Hence their extermination should be aimed at in every practicable manner.

VI. THE RESULTS OF RECENT RESEARCHES ON MALARIA.*

By Dr. Hans Schœffer.

ALL experience and observation hitherto made on the nature of malarial diseases points very decisively to the fact that its true cause must be sought in the soil of those localities in which such diseases are prevalent.

If we search for the factors and the circumstances which favour the development of the supposed exciter of the malarial process, we are struck by the accordant statement that malarial disease occurs endemically, especially where the physical condition of the soil or that of the subsoil prevents a rapid efflux of the water.

Such conditions prevail most decidedly in swamps. Here accordingly it is found that malaria prevails most intensely when, in the dry season, the ground is covered only with a shallow layer of water, and is here and there laid bare. As long as the swampy ground is entirely under water the generation of malaria is trifling or altogether wanting. Hence we do not find malaria in all swampy regions. In hot climates especially there are extensive swamps where it is practically absent.

[As an affirmative instance may here be mentioned the Dismal Swamp of North Carolina, where " fever and chills " are less prevalent than in the fairly dry cultivated lands of the same State.]

On the other hand, malaria is encountered not merely in swamps, but also in well-watered valleys exposed to frequent inundations, where, in consequence of their position, the waters cannot drain rapidly away. Such conditions are found in clays and alluvial soils, which always contain a sufficiency of water, at least in their lower strata.

Under other circumstances malaria occurs, even on apparently very dry ground, when beneath the porous surface-soil there lies an impervious subsoil. Thus foci of malaria may occur in elevated districts, and even in mountain chains. Thus they exist in the Apennines of Tuscany at the height of 1100 feet, in the Pyrennees at 5000, and in Peru up to 10,000 to 11,000 feet. In Italy especially, according to an approximate calculation, two-thirds of the malarious regions occur on hills, and even on mountains.

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* A Discourse delivered before the Vienna College of Physicians.

Experience teaches us, therefore, that malaria occurs only when the surface-soil dries up to such an extent that the atmospheric air is enabled to penetrate to a certain depth—*i.e.*, to those strata which retain their moisture even in the hot season. The access of atmospheric air is of such importance that an old malarial soil can be covered over by natural or artificial deposits, and in a manner buried. It then produces no malaria as long as the superimposed deposits form a sufficiently compact layer. But the malaria reappears when the swampy soil is separated from the atmosphere only by a thin loose stratum of soil, and especially when by any contingency a direct communication is opened up between the atmosphere and the malariferous subsoil.

[Here belong, possibly, the pestilential outbreaks which have been recorded as following earthquakes.]

From this point of view we may regard the appearance of malaria on turning up so-called virgin soils, in constructing railways, canals, harbours, fortifications, &c., in consequence of the inversion and disturbance of the earth occasioned.

Such and similar observations show that the malarial germ inheres in the soil. They prove also that it requires the mediation of the atmosphere in order that it may be developed, or at least extend itself. The production of malaria can therefore occur almost everywhere—in swampy soils, and in soils apparently very dry; in soils rich in organic putrescible matter, as well as in such as are almost free from such substances.

The word malaria—bad air—was accordingly accepted almost universally, in order to indicate the cause of intermittent and malignant fevers. In consequence of more recent investigations we imply by it an agent which may infect every kind of soil, whatever its geological origin or chemical composition.

The production of malaria takes place, however, only in certain well-defined conditions, and there are in this respect three factors, whose co-operation gives rise to the poison:—

1. A fairly high temperature.
2. Permanent moderate moisture of the soil.
3. Access of the atmospheric air to the moist strata.

[Unfortunately these are at the same time the elements of fertility, so that Nature seems to give man the grim choice between famine and pestilence.]

As regards the influence of temperature, it may be mentioned that for the most part malaria does not occur beyond 63° N. latitude and 57° S. latitude; from these limits it increases towards the Equator, with a gradual increase both in intensity and extent.

[If we consider that in the Southern Hemisphere there are mere desolate islands, such as South Shetland at 57° latitude, we shall not lay great weight upon the southern limit above given. But according to many authorities malaria is much less general than in the Northern at such latitudes as 40°, and even 30°.]

Here the question is not so much the mean annual as the mean summer temperature. If, in a region where malaria is generally frequent, the mean summer temperature is exceptionally low, *e.g.*, below 68° F., the malarial forms occur slightly or not at all. If the temperature rises they become more intense.

[It must here be remembered that up to the earlier part of the last century malaria was regularly present in Lincolnshire and other parts of the eastern coast of England, though a mean summer temperature of 68° F. is certainly very exceptional.]

The second factor necessary for the development of malaria in the soil is the access of air to the malariferous strata of the soil. If in low grounds there often occur inundations which carry with them and deposit much earth, there is formed by degrees an accumulation of soil which, if thick and dense enough, cuts off the access of the air to the subsoil, and thus stops the development of malaria. This is a form of sanitation which often takes place without human aid [but which is sometimes imitated by man. "Warping," as it is called, is proposed as a means for the sanitation of the malarial low grounds near Rome].

If, inversely, such old buried malarial foci are laid bare and turned up in the course of engineering or agricultural operations, the fevers reappear. Hence we may conclude that the malarial germ requires for its development the access of atmospheric air; it is an ærobic organism.

With the importance of the access of air to the malarious subsoil the existence of moisture is closely connected. The occurrence of malaria in relatively dry, elevated regions, teaches us that a very moderate degree of moisture is sufficient for the production of malaria.

[Here then comes a difficulty: how can we drain the subsoils sufficiently without letting in the air?]

If for a long time no rain has fallen, so that the soil loses all its moisture by evaporation, the production of malaria ceases, and decidedly malarious soils may remain harmless during the whole course of a hot dry summer. This may be called a natural hydraulic sanitation. But if the ground is then moistened by rain, of even brief duration, there may occur—so to speak—an explosion of malaria.

With us a wet spring and summer, followed by heat, are favourable conditions for malaria. If before the commencement of the hot season the ground has been thoroughly soaked in rain, and if it is then exposed to an elevated temperature, so that it dries on the surface, the development of malaria begins. In some cases it is even found possible to show a direct proportion between the extent of the endemic and the quantity of rainfall. Thus it is known that both the malignity and the generality of malarial fever are directly as the rainfall in the past winter and spring. Not that the great quantity of moisture has any direct influence, but that the moisture of the soils persists longer, and with it the endemic.

A short cessation of the production of malaria in the soil does not suffice to destroy its cause, the disease-germs in the soil. They remain merely in a latent condition, and can again develop their destructive action as soon as the necessary conditions are reproduced.

The attempts hitherto made for the sanitation of malarious districts have been guided by the opinion that malaria originated only in swamps or swamp-like localities, and where masses of organic refuse were slowly undergoing decomposition. Since then it has been held sufficient for sanitary purposes to promote and regulate the constant efflux of the water, thus eliminating one factor only.

In fact thermic sanitation, such as is produced by Nature in winter, is impracticable, because we cannot diminish the action of the solar rays. [To do so would be suicidal, were it in our power.] Hence we can only act upon the two remaining factors.

The systems of hydraulic sanitation are very various, since the problem of removing the moisture of the soil during the hot season admits of various solutions, according to the locality. Drains, open or covered, may answer the purpose of conveying large quantities of water from the malarial soil. In other cases the natural drainage of the soil sucks out and carries away the subterranean moisture. Thus the level of the "ground-water" is lowered, so that it can no longer reach and keep moist the malarial strata which are exposed to the action of the atmospheric air.

Those sanitations which are aimed at by laying malarial districts bare of trees are of a purely hydraulic nature. [Surely some of the most malarial districts of the world—such as the neighbourhood of Rome, many parts of India, Peru, &c.—are distinguished by the absence of woods.] Whilst we formerly spoke of the action of woods in purifying the air and filtering out the malaria, the conviction gains ground that, as the destruction of the woods removes a hindrance to the direct action of the solar rays upon the soil, to remove all moisture during the hot season in districts with a shallow soil would improve their salubrity. [The desiccation of the subsoil by the action of the sun's rays upon the surface is an exceedingly slow process. Trees which send their roots down to the lower strata, and suck up large quantities of moisture, are more effectual than the direct action of the sun on the surface.]

So long as the nature of malaria was sought for in the "miasmatic, putrid exhalations of the swamps," this view of the protective action of forests had a similar meaning to the plantations of Eucalyptus, whose powerful aroma was to destroy the poisonous exhalations. But favourable as is the action of rapidly growing plants in promoting the drainage of the soil, the experiments with the Eucalyptus in Pola and Italy were not satisfactory. The trees are very sensitive, and easily suffer from frost. [This, of course, does not apply to climates warmer than Italy.] They are often damaged by the wind, and they are costly. A specific action can scarcely be admitted, since there are in Australia entire forests of Eucalyptus in districts where malaria is endemic. [Without admitting half of what has been said concerning the efficacy of the Eucalyptus, we may still ask Why should Australia, in a lower latitude than Italy, suffer so much less from malaria ?] It cannnot be valued more highly than other water-absorbing plants, such as the sunflower.

VII. POISON-SECRETERS.

By J. W. SLATER.

ONE of the most interesting phenomena in the organic world is the power which many species—vegetable as well as animal—possess of elaborating poisons. These poisons differ among themselves most widely in almost every imaginable respect, and present a host of unsolved problems, to some of which I shall have occasion to refer. But, with few exceptions, they surpass the mineral poisons in deadliness. Arsenic and corrosive sublimate are inert or mild as compared with the aconitine of the vegetable world or the "cobric acid" of the animal kingdom.

This fact, it may be remarked in passing, throws a somewhat novel light on the statement so commonly found in advertisements of quack medicines, that they, being of "purely vegetable origin," may be taken without danger.

The first point which strikes us in glancing over the long roll of organic poisons is, that they fall naturally into two great classes, the offensive and the defensive. This distinction lies not in the poisons themselves, but in the circumstances that the creatures elaborating the former class are provided with some special apparatus by means of which they can introduce the deadly secretion into the body of their prey, or of a supposed enemy. The purely defensive poisons, on the other hand, exist in the body of some plant or animal, and are perfectly harmless if let alone. But as soon as any animal devours, or attempts to devour, or in some cases merely touches the poison-bearer, it suffers pain, sickness, or death. Such defensive poisons are most common in vegetals, where they occur sometimes in the entire plant, but sometimes only in one particular part, such as the seeds or the root, other parts remaining wholesome.

Certain animals also are in possession of defensive poisons. The common toad is a striking instance. This creature has undergone strange vicissitudes of reputation. In the olden time it was unhesitatingly ranked as malignantly venomous:—

> "Toad that under the cold stone
> Days and nights has thirty-one
> Sweltered venom sleeping got."

Then as this animal became better known, and was found to be utterly devoid of any appliance by which poison might be instilled into the human or other animal body,—such as a sting, a rostrum, grooved teeth, or indeed teeth of any kind,—its innocence was distinctly proclaimed. And innocent he undoubtedly is, to man. He may be handled with absolute safety, as we know from abundant experience.

Still, for all this, the toad is venomous. Everyone who knows a toad from a frog must have noticed the pustules with which the skin of the former is in many parts covered. These pustules secrete a watery liquid, the chemical composition of which is by no means fully known, but which is unquestionably poisonous. In proof, if the courteous reader thinks proper to apply a little of this liquid to his lips, or to his eyeball,—painful experiments on an animal which may be performed without the gracious permission of the Home Secretary, but which I do not recommend,—he will feel a very considerable degree of irritation, and in case of the eye he may very probably require medical advice. Several other Batrachians are similarly provided. They are utterly unable to bite, sting, or otherwise insert venom into the human system, but the secretions of their skins or of their pustules are unquestionably poisonous, and if applied to a wound, or to a mucous membrane, injury will result. Even the common frog in his unskinned condition is not quite to be trusted in this respect.

My late friend Thomas Belt mentions a red and blue frog, common in Nicaragua, which is avoided by fowls and ducks. He managed to induce a young duck to snatch up one of the little frogs. "Instead of swallowing it, however, it instantly threw it out of its mouth, and went about jerking its head as if trying to throw off some unpleasant taste."

But of all Amphibians the earth salamander, *Salamandra terrestris*, enjoys in the countries where it occurs the most evil reputation. It was supposed to be able to kill by a mere touch,—according to some rustic sages even by a look,—and to render vegetables unwholesome merely by creeping over them. In the second quarter of this century it was far from uncommon near mountain streams on the frontiers of Bohemia, Moravia, and Hungary, where its jet-black colour, relieved by irregular yellow or orange blotches, made it a very conspicuous object. To pelt this inoffensive creature with stones from behind a tree-trunk was considered among the village boys of those parts a very heroic feat.

Not a few fishes, mollusks, and crustaceans enjoy also the repute of being dangerous, or even deadly, if swallowed,—

and this with perfect truth. But concerning these animals there remains very much to be ascertained. In most of these cases we do not know whether the poison is physiological, *i.e.*, existing in the animal when in its normal condition, or pathological, developed only in consequence of some disease. Indeed when the fish, &c., are not consumed immediately on being taken from the sea, there is a third possibility,—that the poison depends on incipient decomposition, and is probably a *ptomaine*.

The number of insects which may prove very dangerous, if eaten, is great,—a consideration which ought to be duly weighed by those who recommend insects as an article of human food. How many species develop cantharidine, the active principle of the so-called Spanish fly, is far from having been thoroughly ascertained. An unfortunate circumstance is that cantharides, though poisonous to all mammalian animals with the exception of the hedgehog, are eaten with impunity by frogs and several kinds of poultry, including, I believe, the common duck. The flesh of such animals becomes poisonous to man and to ordinary carnivorous animals. Inflammation of the bladder is not uncommon among French soldiers in Algeria, in consequence of their consuming frogs which have fed on these insects.

Instances are on record that poultry, including ducks, have been poisoned by feasting on the "Colorado beetle" (*Leptinotarsa decemlineata*), and by some kinds of caterpillars not properly identified. It is, indeed, very probable that caterpillars feeding upon poisonous plants will prove deadly. Such caterpillars are generally very conspicuously coloured, as if in warning.

We have now to consider the question, Of what use are defensive poisons either to plants or to animals? It is contended that the death of the devourer can be of no benefit to the plant or animal devoured, and will not serve as a protection to others of the same species, since dead birds and dead insects, like dead men, tell no tales.

But against this argument we may set the indisputable fact that unwholesome plants, insects, &c., are very generally avoided by such species as would otherwise be likely to prey upon them. It by no means follows that a fatal dose will always be taken. Differences in the quantity consumed, in the previous state of the stomach, as full or empty, and in the constitution of the eater, cannot fail to make themselves felt. He may come off with an illness, more or less severe, but not fatal, and will in future shun the cause of his sufferings. In whatever way it may be effected, such knowledge spreads, just as does that of any new or newly-recognised source of danger. Hence it is not unfair to conclude that the possession of defensive poisons is a safeguard to the animal or plant in question. That this protection is not universally efficacious must be admitted. The poisonous nature of the foxglove does not save its leaves from being riddled by snails. The fact that they are saturated with cantharidine is no safeguard to certain beetles against being munched by hedgehogs and gobbled by ducks. If we ask the elder naturalists for an explanation of these cases, they tell us that the snail is specially adapted to keep down the growth of the foxglove, and the hedgehog commissioned to hold the Spanish fly in check. If we turn to the advocate of Natural Selection, he will inform us that the Spanish fly has developed a poisonous property by which it defies its enemies, or, in other words, that it has survived in virtue of having developed such property, whilst its assailant, the hedgehog, survives (or at least possesses a certain advantage) in virtue of having developed an immunity against this poisonous property. I can scarcely see that the latter answer is more satisfactory than the former. Both accept the notion of a game of cross-purposes,—of an Agency undoing with one hand what it does with the other. Neither tells us why one plant or animal should be protected rather than others, or, if protected at all, why this object should be effected in one case by poisons, and in another by a nauseous smell or taste. Do such points depend on mere chance?

In plants, at least, evil scents and flavours often prove a most efficient safeguard. I know of no plant which enjoys such complete immunity from slugs, caterpillars, and aphides as does the Escholtzia, free from poison, but saturated with an intensely bitter principle.

But I must now turn to the offensive poisons,—those which, by one or other means, are introduced into the body of some victim against its will. As usual in Nature, there are here marks of continuity,—intermediate links,—so that we may often stand in doubt to which class a given poison is to be referred.

We read of plants—though more precise knowledge is here needed—which can injure by odours emitted, or by the dew which drops from their branches during the night. The sensational accounts of the upas-tree of Java, and its death-valley, are now relegated to the sphere of the mythical. But it seems possible that persons of susceptible constitutions may be injured by sitting, and especially by sleeping, under the shade of the yew-tree. But here, and still more in the case of the *Hippomane mancinella* of Cuba, and of certain other tropical trees, further investigation is needed.

Among animals an intermediate position seems to be taken by the venomous hairs of many caterpillars, which contain and emit formic acid in a very concentrated form. A bird or other animal seeking to make a prey of such caterpillars is almost certain to receive envenomed wounds. But the hairs become detached as the caterpillar creeps about, and are carried away by the wind. The nests of some of these species should be approached from the leeward side, or they may produce painful inflammations on the face, and if carried into the lungs they may prove fatal. Certain oak-woods in France and Germany are shunned by the country people during summer, on account of these insects.

As a further stage in the direction of offensiveness, we may note the projection of noisome or corrosive secretions to some distance. Thus the "bombardier beetles" (*Brachini*) emit an acid vapour or highly volatile liquid, which instantly evaporates, accompanied by a faint explosion. *Cychrus rostratus* projects a drop of concentrated formic acid to the distance of some inches. If this liquid touches the face it causes a painful blister.

Passing over a number of insects which if handled or alarmed emit liquids of unknown composition, we come to the skunk. The abominable secretion which this creature projects if annoyed may fairly rank among poisons, since it produces violent sickness if the fume is inhaled, and since a drop, entering the eye of a dog, has been known to produce blindness.

But we must now hasten to those creatures which can employ their poisonous secretions as the means of offence by the instrumentality of special organs.

Among these we find only one group of plants,—the nettles. If touched they sting, by conveying through their hollow hairs minute drops of formic acid. Such is, at least, the poison present in the common nettle of Europe; but some more potent poison—perhaps a homologue of formic acid not yet examined—must be present in certain tropical species. The effects of *Urtica urentissima*, of Timor, may last for months, and may terminate fatally. The "devil's leaf," of Ceylon, has produced almost instantaneous death, whilst an Australian nettle, about which exact information is lacking, is said to be rapidly fatal to horses, whilst to man it is not more formidable than the English nettle.

The possession of poisoned weapons is very common in the animal kingdom, chiefly among the Arthropods, much more rarely among the Vertebrates. Among the latter it is met with only in two of the lower classes, the fishes and the reptiles. No warm-blooded vertebrate—in other words, no bird or mammal in its normal condition—possesses a sting or poison-fangs.* It may be added that no such creature is even defensively poisonous. Now as the power of secreting and instilling venom, like that of spinning silk, would undoubtedly be useful to certain birds and mammals, it becomes probable that, as we ascend the animal scale, the power of evolving varied chemical compounds and of the necessary organs for their use becomes feebler.

It has been asked, Why are all poison-armed animals carnivorous? Some have asserted that to them poisons are of greater service than to plant-feeders, as giving them facilities for the capture of their prey. Others have suggested that poisons may be secreted more readily from animal than from vegetable matter. But this dispute is at once cut short by the fact that the honey-bee and its near allies, feeding on honey, pollen, and occasionally on the juices of fruits and the sweet sap of trees, are also armed with stings.

One of the most remarkable features in the poison-bearers is the diversity that prevails not only in the apparatus employed, but in the poison itself. Thus in the venomous fishes we find certain of the spines of the dorsal fins hollow, and placed in communication with a poison-bag or gland at their base. In the venomous lizard, *Heloderma*, we have the ordinary teeth. In poisonous serpents there are special fangs provided with a duct, and receiving their supply from a gland which is a modification of one of the ordinary salivary glands.

We may here consider that the saliva of the dog, when modified by a certain disease, becomes deadly, and remember Oken's hypothesis, that the normal saliva of all animals seems—in addition to its chemical functions—to have the task of extinguishing the molecular life in the animals or plants eaten.

But there is one serpent which, if Australian reports are to be depended on, instils its venom in a quite exceptional manner. It is said to have, at the extremity of its tail, a hard, bony sting, with its accessory poison-gland. In attacking it seizes hold of its enemy with its jaws, and, curving up its body, drives the sting into any part within reach. I very much wish that this strange story might be either verified or refuted.

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* I reserve the doubtful case of the *Ornithorrhynchus*.

In the venomous Hymenoptera—bees, wasps, and hornets—the weapon is a modification of the secondary generative organs. The sting of the scorpion, though situate at the posterior end of the body, is totally dissimilar to that of the bee. It is a special development of the extremity of the body. The spiders envenom by means of specialised antennæ, and the centipedes by peculiarly developed fore legs which have lost their progressive function. In the suctorial insects, such as Hemiptera and certain Diptera, the venom is conveyed by the tube through which food is taken up.

An interesting feature is that where silk-spinning and poison-secreting occur in the same animal the organs for these two purposes exist at opposite extremities of the body.

Concerning the chemical nature of the venoms secreted by different animals little definite is known. The secretions of species not very remote from each other are by no means identical. The poison of the bees and the ants is acid, that of the wasps and hornets alkaline.

Concerning the venom of serpents, it is not yet decisively known whether we have here to do with a chemical individual,—such, *e. g.*, as a ptomaine,—or with an organised virus, like that of plague or cholera, capable of reproducing itself and multiplying in the body of the victim. Here authorities differ, and crucial experiments are on British soil almost impossible, thanks to the Bestiarian agitation.

For young naturalists residing in tropical and semitropical countries there is here a splendid field for research.

VIII. STRASSBURGER'S THEORY OF GENERATION.

E. STRASSBURGER had added to his former numerous researches on the history of the development of organisms a new and important investigation, in which he attempts to solve the problem of generation. His researches which have been made upon plants, though they are to a great extent applicable to all living beings, have been published as a separate work,* and are being discussed in the "Naturforscher."

From the author's observations on the process of fecundation in phanerogamous plants, there appear three facts :—

1. The process of fecundation depends on the conjugation of the nucleus of the male sperm-cell on its introduction into the ovum, with the nucleus of the female germ-cell or ovum-cell.
2. The plasma of the fecundative cells not belonging to the nucleus (cytoplasm) takes no part in the process of fecundation.
3. Both sperm-cell and germ-cell are true cell-nuclei.

As for the efficacy of the cytoplasm in the process of fecundation, it serves merely as a vehicle in order to convey the sperm-cells to the place of their destination. It plays here, therefore, the same part as do the cilia of the spermatozoids of cryptogamous plants.

Hence, if we generalise the relations established for phanerogamous plants by extending them to all living beings, the offspring can inherit the properties of its parents solely by the mediation of the cell-nuclei. Therefore the specific distinctions of the organism must have their foundation in the properties of these cell-nuclei. Each cell-nucleus contains (as it is already well-known), as its framework, an anastomising manifold intertwined thread, the so-called "nuclear thread," consisting of a transparent substance, the nucleo-hyaloplasm, in which are imbedded numerous small granules, the nucleo-microsomes.

Between the windings of this nuclear thread there lie the nuclear corpuscles (nucleoli), one or more. The entire framework is placed in a nuclear cavity filled with the nuclear fluid and surrounded by the nuclear wall, which Strassburger regards as a membranous layer of the surrounding cytoplasm. This nuclear wall is internally in contact with the windings of the nuclear framework, but he does not assume a direct continuation of the cytoplasmic threads into the framework of the nucleus. The reciprocal action between the stationary nuclei and the cytoplasm is therefore merely dynamical,—*i.e.*, it takes place without any transportation of matter. The nutriment which the young cell-nucleus requires after fission, to complement its mass, issues in a soluble state from the cytoplasm, and passes through the nuclear wall. When a division of the nucleus is to follow, the nuclear threads contract and the microsomes coalesce with each other to form disk-shaped structures. A portion of the hyaloplasm also contributes to the formation of these disks. This portion of the hyaloplasm which has passed into the microsome disks must have been present in the stationary cell-nucleus as an active nutrient plasm (nutritive nucleo-plasm). The residual portion of the hyaloplasm, which may still be detected between the microsome disks, and which probably covers them with a delicate coating, is to be regarded as active, formative plasmas. This formative nucleo-hyaloplasm corresponds with Naegeli's "idioplasm,"—*i.e.*, that part of the plasma which contains the hereditary tendencies.

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* Neue Untersuchungen ueber den Befruchtungs vorgang bei den Phanerogamen as Grundlage für eine Theorie der Zeugung. Jena, 1884.

That we must also distinguish a nutritive and a formative hyaloplasm in the cytoplasm, where a firm texture is wanting, seems to follow from the processes in nuclear division. In this operation the cytoplasm penetrates into the nuclear cavity and produces the spindle-shaped fibres, which, when the separation of the filial nuclei has taken place, remain as connective threads, and allow of the formation of the cell-plate from which the young partition-wall proceeds. Strassburger is inclined to regard these threads as the formative plasma of the cytoplasm. The equatorial parts of such threads remain as exceedingly delicate connective threads in the partition-wall, and maintain the connection between the single cytoplasts of the body of the plant.

This formative cyto-hyaloplasm is, in a certain manner, idioplasm of the second order. It is to be regarded as the organ of adaptation, whilst the cell-nucleus represents the conservative principle in the organism. As far back as 1866 Haeckel came to the conclusion that the nucleus mediates the transmission of the hereditary characters, whilst the external plasma is concerned with adaptation. Molecular excitements are propagated from the nucleus-cell to the surrounding cytoplasm, which, on the one hand, control the processes of the transformation of matter in the cell, and, on the other, impart the peculiar character of the species to the growth of the cytoplasm conditioned by nutrition. The cytoplasm in return reacts upon the cell-nucleus, exciting its divisions and determining its nutrition.

In opposition to Nussbaum and Weismann, and in accord with Naegeli, Strassburger assumes that the germinal substance in the course of ontogeny does not pass unchanged into the organism (the substances determined for the germinal cells being early separated from the remaining substances of the body), but that they are produced anew from the modified idioplasm by a process of reverted development. In a certain sense the nuclear substance fulfils the conditions which Weismann demands from germinal substance, for it passes through the body in a separate condition, in so far that the dynamic influences proceeding from the cytoplasm and acting upon it have little influence upon the specific attributes of the nuclei. The individual acquired properties remain connected with the idio-cytoplasm, and are transferred only along with this, as in the improvement of plants. In common with Weismann, Pflüger, and Naegeli, Strassburger opposes the exaggerated importance atttributed to individually acquired properties, and, with Naegeli, he seeks for the causes of the changes of the organism not in outward, but in inward factors, namely, in the molecular forces inhering in the substance.

In copulation only those elements of the generative cell-nuclei become mixed which are not morphologically differentiated. The nuclear threads on both sides do not coalesce, but merely apply themselves to each other. Not until the fission of the germinal nucleus does the process of coalescence ensue in the secondary nuclei. In the germinal nucleus preparing for division the framework contracts to a short thread, which is resolved into segments. These again are split up longitudinally, and these halves of each segment are distributed equally to the two secondary nuclei.

In these the nuclear thread segments coalesce with their ends to a single nuclear thread, which is thus composed half of segments derived from the father and half of those springing from the mother. These pieces must have been again derived each from both grandparents. It is clear that both these parts become the smaller the more remote the generations to which they belonged. The portions of the thread derived from the same ancestral pair are distributed in small fragments through the entire thread. If, then, accidentally several segments derived from the same progenitor are brought together, they acquire a certain influence which can occasion in a given part of the organism a phenomenon of reversion. The more remote the generations from which they are derived the smaller are the segments, and the less is the probability of their manifestation. But Strassburger, like Naegeli, refers the ordinary phenomena of atavism, which consists in the fact that some given property overleaps one generation to reappear in the next,—not to the re-union of segments of the nuclear thread, but to a latency of the phenomena in question.

Both the sperm-nucleus and the ovum-nucleus unite the properties needful for the formation of both sexes. There are no morphological facts known which could necessitate the assumption of a functional difference in the two conjugated cell-nuclei. The view that the specifically male elements are previously expelled from the sperm-nucleus, and the specifically female elements from the ovum-nucleus, is refuted by the circumstance that sexual attributes of the grandmother can be transferred through the father to the granddaughter, and, inversely, sexual peculiarities of the grandfather through the mother to the grandson. The influences which lead to the development of one or the other sex may possibly act upon the sexual products during their elaboration of the ancestral organism. The tendency to produce a given sex may be developed in the two conjugated cell-nuclei either in the same or in opposite directions, in which latter case the stronger predominates. A perfect equilibrium of the tendencies of cell-nuclei having opposite directions is also possible, the result being the formation of a hermaphrodite.

ANALYSES OF BOOKS.

English Worthies. Edited by ANDREW LANG.
Charles Darwin. By GRANT ALLEN. London: Longmans, Green, and Co.

YEARS must pass before Charles Darwin's exact position in the history of science can be definitely and finally established. At present disputes concerning his merit and even his personal character are still raging. If he is no longer assailed by the organs of religious opinion, as in the years immediately succeeding the appearance of the "Origin of Species" and the "Descent of Man," it must not be supposed that he everywhere meets with due honour and appreciation. The anti-Darwinian warfare has been taken up by authors who, whatever else may be their motive, certainly do not speak in the name and in the interests of Christianity, for which some of them do not care a straw. In view, therefore, of the writings of Mr. Samuel Butler and Mr. Oswald Dawson, it is well that a full and fair exposition of the views, the methods, and the merits of our great English biologist should be laid before the public.

Such an exposition will be found in the work before us. Its author, Mr. Grant Allen, is not merely an evolutionist in the wider sense of the term. He is a Darwinian of the Darwinians—an orthodox believer in natural selection. That whatever he knows and believes he can clothe in pellucid language, not merely intelligible but fascinating to the great "educated and respectable" classes, will be readily admitted by all persons who are familiar with his numerous contributions to periodical literature. Accordingly we meet in this volume little, perhaps, which is novel, profound, or suggestive, but abundance of thoughts expressed with a singular felicity. In the very outset he reminds the reader of what many fail to see, that a great man has, so to speak, a two-fold line of ancestry—his bodily parents, grandparents, and more remote ancestors from whom he derives his personal qualifications, and, on the other hand, his forerunners, or, as Mr. Allen calls them, "his intellectual and moral ancestors, the thinkers and workers who have preceded him in his own department of thought." All this, and its corollaries, are known, of course, to every reflective mind, but few could have expressed this important truth so happily as it may be found in the book before us.

Starting from this basis, Mr. Allen combats the popular mis-apprehension which regards Darwin as the discoverer and founder of the hypothesis of evolution, the first to suppose animal and vegetable forms to be the outcome, not of special, mechanical creation, but of slow modification in pre-existing organisms, and especially the first to suggest the possible descent of man from an ape-like ancestor. This position had, however, been previously taken by others, for instance, Buffon, and Darwin never for a moment represents himself as having been its originator. His task was to show how descent with modifications might be effected—to make the theory of development comprehensible and believable.

Our author, in order to refute this misconception, gives a sketch of the evolutionary doctrine as it was held by some of the most eminent naturalists prior to the avatar of Darwin.

In this survey we find Lamarck characterised as "a bold, acute, and vigorous thinker, trained in the great school of Diderot and D'Alembert, with something of the vivid Celtic poetic imagination, and a fearless habit of forming his own conclusions irrespective of common or preconceived ideas." But has it never struck Mr. Allen what a large proportion of the opponents of Evolution in general, and of Darwinism in particular, are manifestly Celts? How Celtic France, the western portion of Switzerland, Ireland, and Scotland, have remained strange or hostile to the new biological school?

Cuvier is characterised as "a reactionary biological conservative and obscurantist." We submit that the term "conservative" is not happily chosen. "Oken," it is said, "was spinning in metaphysical Germany his fanciful parodies of the Lamarckian hypothesis." Those who are familiar with Oken's works in the original, and especially the few survivors of his pupils, will think that he here receives but scant justice. It is startling to reflect how many of the most advanced conceptions of modern science lurk in germ in the strange and, at times, uncouth phraseology of his writings. But to return, in the account of Darwin's early days we find some remarks which we can most heartily endorse. Thus: "The boy was educated (so they call it) at Shrewsbury Grammar School, and there he picked up as much Latin and Greek as was then considered absolutely essential to the due production of an English gentleman. Happily for the world, having no taste for the classics, he escaped the ordeal with little injury to his individuality." After a short stay at Edinburgh University, he proceeded to Christ's College, Cambridge. "The Darwins were luckily a Cambridge family: luckily, let us say, for had it been otherwise—had young Darwin been distorted from his native bent by Plato and Aristotle, and plunged deep into the mysteries of Barbara and Celarent, as would infallibly have happened to him at the sister university, who can tell how long we might have had to wait in vain for the "Origin of Species" and the "Descent of Man?" But

Cambridge, which rejoiced already in the glory of Newton, was now to match it by the glory of Darwin. In its academical course the mathematical wedge had always kept a dim path open for physical science."

In the same spirit Mr. Allen further writes: "Fortunately for us, then, Darwin did not waste his time at Cambridge over the vain and frivolous pursuits of the classical tripos. He preferred to work at his own subjects in his own way, and to leave the short-lived honours of the 'schools' to those who cared for them and for nothing higher. . . . . He chose that better part which shall not be taken away from him as long as the very memory of science survives." We cannot help exclaiming, honour to the man who, in this land of still rampant 'humanists,' dares to speak so plainly of word-mongering! In this work we find no mention of the fact that Robert Darwin destined his illustrious son for the Church, and with difficulty consented to his joining the ever-memorable "Beagle" expedition. What a danger escaped!

Passing over the narrative of this voyage, the lessons of which are brought into full light, we come to the "period of incubation," when the observations which young Darwin had made in his wanderings were being co-ordinated into the great body of evolutionary doctrine. Here a saying of Professor Fiske's is very appositely quoted: "There is one thing which a man of original scientific genius in a rightly-ordered world should never be called upon to do. He should never be called upon to earn a living, for that is a wretched waste of energy in which the highest intellectual power is sure to suffer serious detriment, and runs the risk of being frittered away into hopeless ruin." This is a wholesome lesson for the believers in competition!

Of the rank and file of scientific workers Mr. Allen speaks, as it seems to us, with too little respect. The great discoverer, in closing every "loop-hole of an objection," does but repeat publicly the process by which he has first convinced himself. "Non-biological minds" may, perhaps, give in their adhesion more readily because they are not familiar with the thousand and one phenomena which a new theory must explain.

Of the "Vestiges of Creation" we find an uncomplimentary notice. It is described as "Lamarck and water, the watery element being due in part to the unnecessary obtrusion (*more scotico*) of a metaphysical and theological principle into the physical universe."

It is, perhaps, surprising that attention is not called to one of the favourable circumstances which attended the first promulgation of the new theory. England was at rest; the Crimean War and the Indian Mutiny were over, and, most of all, there was no political agitation on foot. Had the "Origin of Species" been first published at any date from 1876 to the present day it would have excited little interest save among specialists.

The arguments both of the friends and the opponents of evolution would have been drowned among the din of organised factions, the orations of itinerant Jack Cades, and the cheers of a multitude rushing violently down a steep place into —— ?

We find here Alfred Russel Wallace spoken of as "a young Welsh biologist." This is surely a mistake. The name Wallace, as well as the *prænomina*, are assuredly not Welsh, and, to the best of our recollection, Mr. Wallace was not born in the Principality.

Concerning the respective merit due to Darwin, Wallace, Wells, Matthew, and Spencer, Mr. Allen writes: "It was Darwin's task to recognise the universal where Wells and Spencer had seen only the particular; to build up a vast and irresistible inductive system, where Matthew and Wallace had but thrown out a pregnant hint of wonderful interest and suggestiveness.

We come now to what appears to us a grave error. Mr. Allen writes: "For the world is perpetually overpopulated. It is not, as many good people imagine, shortly going to be overpopulated; it is now, it has always been, and it always will be, pressed close up to the utmost limits of population." If the world had always been overpopulated, how did it happen that children were regarded not as a burden but as a blessing? How came it that, in the days of Queen Elizabeth, as Hallam shows in his "Constitutional History of England," the wages of a working-man represented a larger proportion of the necessaries of life than they do in our progressive days? What, lastly, has become of "the full-blooded tendency of the eighteenth century" which Mr. Allen himself mentions? Even in the lower animals, where Mr. Allen is nearer the truth than with respect to man, we find that certain wild species must have fearfully increased.

Again the author considers that most people "misunderstand the meaning of the phrase 'struggle for existence.' They imagine that the struggle is chiefly conducted between different species, whereas it is chiefly conducted between members of the same species." But what exterminated the native flora and fauna of St. Helena? The goat. What is laying waste South Africa, so that a troop of the Cape Mounted Rifles actually cheered on meeting with a tree when on the march? The goat. What are fast eradicating the interesting native floras of West Australia and California? European weeds. These and other instances on the large scale show that there is a most desperate struggle between different species, and that this struggle, when it becomes sufficiently intensified, instead of forming new varieties or species, leads to their extermination.

Mr. Allen's work deserves careful perusal by all who would wish to form a truer estimate of Darwin than that which they might gather from the works of Mr. S. Butler.

Our Insect Enemies. By THEODORE WOOD. London: Society for Promoting Christian Knowledge.

WE have here a little book full of most useful information concerning that very numerous class of beings, insect pests. It will, we hope, help to teach John Bull the lesson which Brother Jonathan has already learned, *viz.*, that insects and their study are not to be despised, since among their ranks we find the most formidable of our animal enemies, with which we cannot hope to grapple successfully so long as we choose to remain in ignorance of their life history. Without endorsing all the author's speculative views upon the possible utilities of certain insects, we think he has done good service by pointing out the many important problems in their economy which still await solution. To take some of these in hand will surely be a more honourable and useful way of studying entomology than that we too often see, *i.e.*, capturing or buying an assortment of "British" Lepidoptera and pinning them, in fantastic patterns, in a glass case.

We notice in the introduction a statement referring to an obsolescent order of things: the Cochineal insect, as a source of scarlet and crimson dyes, is fast becoming a thing of the past.

Mr. Wood's remarks on the inestimable services rendered us by carnivorous insects and insectivorous birds are well timed. We often slaughter our allies out of ignorance or prejudice. But we are unable to accept his pleadings in favour of the sparrow. Not only is it, during the greater part of its life, a destroyer of grain, fruits, and blossoms, but, by its too often successful persecution of the martin and the swallow, our great safeguard against the multiplication of gnats, it inflicts on us a serious injury. Where the extirpation of sparrows in any locality has been followed by the increase of caterpillars, &c., we believe it will be found that the mischief has a very different cause. The truly insectivorous birds have been scared away by the clumsy methods taken for the slaughter of the sparrows. This much is certain, that wherever the sparrow has been introduced, in America, Australia, and New Zealand, it has been pronounced an unmitigated nuisance by a majority both of naturalists and of farmers and gardeners. Sparrows have been shot and the contents of their crops carefully examined under the microscope, with the result that insects do not form one-tenth of the diet of these depredators.

Amongst the enemies of the Aphides one, or rather a group, is here overlooked. The beetles of the genus Telephorus, popularly known as "soldiers and sailors," and several of their near allies, are indefatigable devourers of the Aphis. Spiders, also, especially of the genus Epeira, ensnare a legion of plant-lice when in their winged state.

An unfortunate fact is that Aphides have their protectors as well as their enemies. Ants not only defend these vermin against attacks, but have even been known to re-introduce them upon trees which have been cleared at great labour and expense.

Hence, as a preliminary to attacking the aphides, it is necessary to wage war against the ants with carbolic acid and corrosive sublimate. We do not find here any reference to ants—such as the leaf-cutters—and to the termites as enemies of man.

The horrible taste and smell of the field bugs, both in this country and abroad, are duly noticed. The author describes very graphically his experience on accidentally swallowing a bug along with the berry upon which it was sitting. He does not exaggerate, for we once put into our mouth a fine blackberry on which a specimen of a beautiful Hungarian species was sitting. We did not swallow the dainty morsel; still we did not get rid of the savour for the remainder of the day. One important point overlooked is the suspicion, now almost amounting to a certainty, that fleas, bed-bugs, mosquitoes, &c., may transfer diseases from one person to another, and may inoculate man with the poison of swamp fever.

The wasp has been here omitted. Yet in districts where they are abundant it is almost impossible to protect choice fruit from its ravages.

"Our Insect Enemies" should be generally read in country districts, and its teachings should be carried into practice.

Proceedings of the Bristol Naturalists' Society. New Series, Vol. IV. Part III (1884-5). Bristol: James Fawn and Son.

THIS volume contains papers on the Mapping of the Millstone Grit at Long Ashton, by Prof. C. Lloyd Morgan, F.G.S., in which the author corrects an error committed by Mr. Sanders in the boundary of the Millstone Grit. Dr. S. F. Burden contributes a paper on the total eclipse of the moon, October 4th, 1884, rendered noteworthy by the unusual fact of the almost total extinction of the moon to the naked eye. He suggests the solar corona as the source of the light which generally illuminates the eclipsed moon. Prof. C. Lloyd Morgan, in a second paper, considers "Sub-aërial denudation and the Avon Gorge." In his conclusion he remarks that "the general denudation which has removed all the inferior oolite, not to mention the newer rocks which almost certainly overlaid it, and nearly all the Lias from our district, demands almost more of our wonder and our faith in geological principles than the special denudation which has cut for us the Avon Gorge."

Mr. Bucknall continues his catalogue of the Fungi of the Bristol district.

Mr. E. Wilson, F.G.S., curator of the Bristol Museum, furnishes notes on a common Fin Whale (*Physalus antiquorum*) recently stranded in the Bristol Channel. Mr. C. T. Druery, F.L.S., gives an account of thenewly-discovered phenomenon of "apospory" in Ferns, *i.e.*, the production of the prothallus upon the parent plant without the mediation of the spore.

From the table of the rainfall at Clifton it appears that the total rainfall there fell short of the average of the last 30 years by less than 1 inch.

Records of the Geological Survey of India. Vol. XVIII., Part 3. 1885.

In this issue we find a paper by Mr. R. D. Oldham on the Geology of the Andaman Islands. The author finds reason to examine the common theory that the Andamans have been and are subsiding. He meets the evidence of subsidence at the present day, which, however, has apparently set in only recently.

Mr. Medlicott furnishes an account of the Pirthalia and Chandpur meteorites. The fall of the latter seems to have been attended by a thunderstorm.

Dr. Romanis reports on the oil-wells and coal in the Thayetmyo district in British Burma. The yield of oil is only about one barrel per month. The coal deposits of the Amakan Yoma seem to have been formed in the swamps and lagoons of a river-delta. Those at Thayetmyo have originated during a period of subsidence. It is thought that there are two seams of four feet in thickness, separated by 60 to 70 feet of shale.

Mr. W. R. Criper communicates a note on the antimony deposits near Maulmein. The ore is found not in lodes, but in disconnected deposits, and seems incapable of profitable working. The rainfall at Maulmein is from 170 to 220 inches yearly.

Proceedings of the Literary and Philosophical Society of Liverpool, during the 73rd Session, 1883-84, No. XXXVIII. London: Longmans, Green, and Co. Liverpool: D. Marples and Co.

This volume contains some valuable papers, though, as is too often the case, matter not of general interest appears, to us at least, to occupy too large a share of space.

The President, Mr. R. Steel, read an important memoir on "Mind in Man and in the Lower Animals," and came to the only legitimate conclusion to be drawn from the facts, *viz.*, that "the processes which go to constitute man's mental activities are found as truly in their measure in the brute," and again "Man's claim to be something entirely different in his powers from the lower animals must be peremptorily dismissed."

Speaking of the senses, he remarks that the higher forms of the brute creation possess as many as man himself." Do not some insects possibly—nay, probably—possess more? What, for instance, is the meaning of the two, and even three, kinds of eyes in certain insects?

"Parrots," Mr. Steele writes, "can repeat many sentences, and obviously connect them with certain subjects. I do not, of course, say that the parrot understands what it says in the same manner that the human being understands the same words? Here one word is wanting; it should have been said "the *adult* human being." A parrot's use of language is very closely similar to that of a child of one and a half or two years of age. The bird distinguishes and applies rightly not only nouns but verbs. We know a parrot which almost invariably says "What you want?" if any person seems to open drawers, turn over papers, &c. "What you got?" if anyone enters the room with a basket or a bag; and "What you doing?" if any unusual action is performed in her presence.

In a discussion on induction he brings forward a caution too commonly overlooked. He writes: It is possible to show from still another point of view the fallacy of postulating these laws (*i.e.*, those of number, space, and causation). The laws of number and space are purely hypothetical. The whole theory of number rests upon an assumption—that of unity. But the idea of unity is a subjective abstraction. There is no such thing in nature or in the compass of our experience as absolute unity, and therefore all arithmetic, which is developed from the idea of absolute unity, is, to our apprehension, exactly true only because in its every step it carries with it the original assumption. But that cannot be an absolutely certain induction which contains in its every step a pure assumption, so that the science of number has no such claim to infallibility as Mill assigns to it."

The Rev. T. P. Kirkman, F.R.S., the author, as our readers will remember, of a "Philosophy without Assumptions," communicates a "Description of the 24-Edra, having only Triad Summits, and for Faces only Pentagons, Hexagons, Heptagons, and Octagons, which are reducible to the regular Dodecahedron." He admits that his results are, "like most mathematical results, of no further use than to prove the power of the method."

Dr. W. A. Herdman is the author of a paper on the "Theory of Heredity," interesting to men of science and hated to persons of the demagogue type, as cutting away some of their pet theories.

Dr. Hayward replies in a paper on the "Modification of Hereditary Transmission by Mental and Educational Influences." We note, in passing, the "*and*." He seeks to uphold the old error that educational and social training, and mental and moral influences (Are not "mental" influences moral influences, and conversely?) are the "most potent of the means for improving the human race." He considers Eugenism—the improvement of the race by judicious marriages—impracticable. Certainly, if the community and the whole species are to be sacrificed to the individual and his whims, this must be the case.

The admirable paper by the Rev. H. Higgins, M.A., on "Museums of Natural History," has already come under our notice in its separate form.

W. G. Black, F.R.Met.S., supplies a paper on "Anemometers for Ships," destined to allow the officer in charge to judge by mechanical means of the force of the wind on the sails at any time required.

Mr. R. J. Gibson, M.A , read a paper on the "Flora and Fauna of Oceanic Isles." His remarks are at present confined to the Açores; on some future occasion he will treat of the Galapagos and St. Helena. A curious contradiction is mentioned as regards the goldfish found on the little volcanic lakes of these islands. On the one hand, we are told that they are so numerous that one cannot put one's head into the water without touching them, "and, on the other hand, that they die by thousands, and their dead bodies are thrown up on the shore all in a condition which show that they have died of starvation, there being no food for them in these lakes." How, then, do they continue so numerous? The author considers that the original life of these islands had a strong resemblance to that of America, but that the present fauna and flora have been mainly introduced from Europe by human instrumentality.

Finally, Dr. J. B. Novins gives an interesting "History of the Introduction of Peruvian Bark Trees (*Chinchonas*), and the Present State of Cultivation in India."

We are still of opinion that all the "Literary and Philosophical" Societies of Britain would be rendered much more healthy and efficient by a process of "dissociation."

Manual of Telegraphy. By W. Williams. London: Longmans, Green, and Co.

This work, as the Preface informs us, has been compiled by order of the Director-General of the Indian Telegraph Department. Its objects are to afford the Staff a means of self-education in practical telegraphy; to serve as a primer and companion to the Department's testing instructions; for the instruction of probationers, and as a text-book of ready reference. Like the vast majority of English manuals in any department of Science, it is based on the substance of "papers set" at general examinations. In its successive sections it considers the definition of technical terms, batteries, instruments, telegraphic circuits, detection and removal of faults, the testing of batteries, of lines, earths, lightning conductors, instruments and connections, besides an Appendix treating of the laws and principles by which the conduct of electrical currents may be understood, and on which the solutions of formulæ are based; also electrical formulæ and their solutions, and a table of natural sines and tangents.

The work is clearly written, well illustrated, and perspicuously arranged.

Journal and Proceedings of the Royal Society of New South Wales for 1884. Vol. XVIII. Edited by A. Liversidge, F.R.S. Sydney: Thomas Richards. London: Trübner and Co.

From the Anniversary Address delivered by the President we learn that of the prizes offered by the Society, for the best Memoirs on certain specified subjects, only two have as yet been awarded. Of the nine Memoirs sent in last year none were found satisfactory. It is to be regretted that, in a country where so much remains to be discovered, there should not be a greater zeal for research.

It appears also that the Society made such a donation to the funds of the Zoological Station established on the coast (a true Aquarium, like the one at Naples) as to entitle it to nominate a worker in the Laboratory, but no one applied for this privilege! If we consider that on the east coast of Australia there must be far greater scope for investigations in Marine Zoology than at Naples, this apathy is much to be regretted. If three publications are needed to chronicle the work done at Naples, six ought at least to be filled with the records of New South Wales researches.

The speaker, in describing his late visit to Europe, mentions that the supply of Iceland spar fit for making Nicol prisms is at an end, the mine being exhausted. Mineralogists would do well to search for new sources of this important crystal. He has made frequent use of a " rain-band spectroscope " for more than a year, but only on one occasion has it given a distinct indication of rain earlier than the usual atmospheric signs.

Reviewing the evening after-glows which have been so much discussed for some time, Prof. Smith concludes that if dust is the source of the phenomenon its origin is cosmic.

Among the Memoirs here inserted we notice in particular :—

The Trochoided Plane, by Lawrence Hargrave. The author contends that the trochoided plane is the mechanical power almost universally used by Nature for the transmission of force in living creatures. As an example he takes the back fin of a fish. " Observation will show that the ends of the spines that keep the membrane extended are points in the curve of sines or trochoidal wave, and that if they are rotated on their axes in unison, or oscillated from side to side harmonically, a series of complementary waves will be thrown by the membrane towards the tail. This action of the fins is best seen when fishes are confined in a bowl, and appears to be only used when the speed does not necessitate the use of the large muscles of the body. . . . If we conceive the action of the back fin as thus described to be communicated to a series of legs on each side, as in the centipede, the effect will obviously be progression along a surface; and if we cut off all the legs but two pairs, separated by a distance equal to one wave-length, we have the quadrupedal action popularly assigned to the giraffe ; if the two pairs are only half a wave-length apart, we have the trotting pace of a horse ; and the various other paces become clearly dependent on the length of the wave used by the animal. The legs and body of an alligator or lizard show the connection between many-legged and four-legged progression. . . . But it is impossible to define any hard-and-fast line between any two classes, as the more instances of progression we notice the more it is forced upon us that they are but links in a chain the two end links of which are unknown, whilst any two adjoining links are hardly distinguishable. The swinging of the hands and arms, in walking and running, is evidence that bipedal is evolved from quadrupedal progression, which to me seems to have developed from the trochoidal action of a fin. When the amplitude of the waves is in a vertical plane, each pair of legs is moved together, and the form of the wave is plainly seen in the back of a dog when going full split (*sic*). This method of progression reaches its extreme form in the hopping birds."

It seems that it might be interesting to re-examine the locomotion of animals from the author's point of view. We regret, however, to find that the author is seeking to apply his theory to the problem of artificial flight, the solution of which, prior to a total change in the moral condition of mankind, would, it seems to us, be the direst calamity conceivable.

Mr. H. C. Russell, the Astronomer Royal for New South Wales, read a Memoir on a new form of Actinometer, to show not only the hours when the Sun shines, but also the intensity of the heat.

Mr. C. Moore, F.L.S., read Notes on the Genus *Doryanthes*, the "Great Lily" of Australia, giving description of a new species. This plant, which grows to the height of 20 feet, is not a true lily, but an *Amaryllis*. It is not only remakable for the beauty of its red flowers, but yields a fibre remarkable for its tenacity and silky lustre. It can be obtained in threads 3 feet long, and can be produced to any extent.

Mr. W. H. Caldwell, M.A., communicated a most important paper on the Development of the *Monotremes* and of the *Ceratodus*. It is interesting to remember that this investigation was suggested to him by the late lamented Professor Balfour. He describes first the reproduction of the marsupials, now the characteristic animals of Australia. The main difference between them and ordinary mammals is that in the latter the embryo before birth has no vascular attachment to the walls of the uterus.

The *Ceratodus* is a representative of a series of animals once very numerous, but having now three living representatives only—the *Ceratodus* of Queensland, the *Lepidosiren* in the Amazon, and the *Propterus* found in certain African streams. These three animals possess gills, and have in their adult state the form of a fish, but they have also lungs. There is an indication of two chambers in the heart, and of the presence of arterial blood. The egg of the *Ceratodus* undergoes a complete segmentation, like that of the kangaroo.

The author's most important discovery is that the *Monotremes* are reproduced by eggs, the *Ornithorynchus* laying two, and the *Echidna* only one. These eggs, like those of birds, and unlike the true mammalian ova, contain a large food yolk. Nevertheless both suckle their young.

It is laughable to find that during the last few weeks before his Memoir was read Mr. Caldwell had received several letters denying that the *Platypus* laid eggs, and wanting to argue about it. Now, as he remarks, a fact may be disbelieved, but it cannot be argued about.

The Kansas City Review. New Series. Vol. IX., No. 1. August, 1885.

This issue contains a very large proportion of interesting and useful matter.

The first article discusses the "Relations of Archæology to History," and makes the startling, though perfectly justifiable, assertion, that "The tremendous physical forces which a single man now summons to his aid may threaten us with a speedy return to barbarism, for certainly the morals of a railroad corporation are no improvement on those of Confucius." Meditating somewhat discursively on this paragraph, we might ask whether ancient civilisations, of which no account has reached us, may not have been overthrown in the manner here hinted? We have seen it somewhere stated that the man whose culture is greatly superior to his wealth is a nuisance to himself, and, on the contrary, he whose wealth exceeds his culture is a nuisance to others. Might it not be said that the nation whose physical and intellectual development exceeds its moral progress is a peril to its neighbours, whilst the one whose moral culture outstrips its physical and intellectual culture is a peril to itself?

May we not also—with a writer in a very heterodox, but thoughtful, contemporary—ask whether the rule of combined capitalists may not prove more grinding than that of any conqueror, feudal baron, or priest of antiquity and the Middle Ages?

We find it further truly said:—"There is no law of limitation with man, except his capacity to take. . . . There is every reason to suppose that the highest development of man is capable of exhausting all the means which the Earth can offer for his support."

A Memoir on the "Industrial Achievements of the Ancients," though revealing no fact absolutely novel to the learned, may act as a wholesome cooling-draught to us moderns, suffering from the fever of self-worship. It is already certain that in our popular speeches and writings we vastly underrate both the abstract knowledge and the industrial skill of the remotest antiquity. But what a light would dawn upon us could we reproduce the books burnt, not by the Caliph Omar, but by the monks of Alexandria?

In a Paper on "Moral Microbes" we find the term used in a novel sense,—applied, that is, to evil impressions implanted in the individual. We have incidentally applied the kindred term "Schizomycetes" to individuals who disorganise the communities among which they live by setting on foot "movements," such as Bestiarianism.

In the "Round of Life" we meet with the remark that "The grand and most obvious distinction [between plants and animals] lies in the fact that all vegetables, except some families of parasitic plants, and perhaps some species described as carnivorous plants, feed alone on inorganic matter, while animals derive their sustenance from organised matter." But surely a distinction which admits such exceptions as are here fully acknowledged can neither be grand nor obvious. If bacteria, &c., were not nourished upon organic matter, how could they either decompose the remains of plants and animals or induce diseases?

"Zoological Enigmas" is a collection of curious but little-known facts in Natural History. The existence of a land serpent of 55 feet in length, like the *ular sawad* which Sir Stamford Raffles saw on the coast of Sumatra, is often forgotten. As for the huge serpents said to have occurred in Europe within historical times we feel very sceptical. "Pliny states that a serpent killed in the Pontine Marshes, during the reign of the Emperor Claudius, had the entire body of a child in its stomach; and Suetonius mentions a python 50 cubits (75 feet) in length, that was killed near Agrigentum in Sicily, and exhibited in front of the Comition." Pliny, however, is an exceedingly poor authority, as in compiling his great work he seems to have gathered up every old wives' fable that came to his ears, without any attempt at verification.

The story of the serpent which, in Numidia, kept a whole Roman army at bay on a ford of the Bagrada, and after killing fourteen soldiers who had attacked it with their swords was at last crushed by a stone hurled from a balista, is more credible as far as the locality is concerned. Even down to the present day huge serpents are said to haunt some of the ravines of the Atlas.

We have next reference to the Brazilian tradition of a monstrous underground serpent which tunnels its way under the roots of the forest, or occasionally overturns large trees. But some versions of the story seem to point rather to a monstrous earthworm. This myth is, we believe, being specially investigated by Dr. Fritz Müller, F.E.S.

The classical myth of the harpy is traced, with great probability, to the "flying fox" of Java and other parts of the Malay Archipelago.

Lastly, the author of this paper discusses the belief in vampires. This belief, in various forms, is widely current in Roumania, Hungary, the South of Russia, and even in Upper Silesia. A recent Hungarian writer contends that this notion has a zoological basis, *viz.*, "the existence of nocturnal *Mindes* allied to the land-leeches of Ceylon, and gifted with the caution of the South-American vampire-bat, which Waterton so well describes. In support of this belief a strange story is given of certain mysterious deaths which had happened in a turret-chamber in the mansion of the Counts Lermonhoff, near Odessa. In 1824 a son of the family, eager to solve the mystery, slept in the turret-chamber, which had been in the meantime cleaned and most carefully examined. The rest of the story we give in the words which we here find:—"He [the steward] was waked by a scream that made his blood freeze. What had happened he was unable to say: all he remembered was, that in his last agony the unfortunate man [the Count's son] had thrown his head to and fro and pressed both his hands over his temple, where they remained even now, firmly interlocked and rigid in death. When they at last succeeded in unclasping his hands they found under his fingers, with its sting imbedded in the seams of its victim's skull, an unknown animal, which can now be seen in a vial of spirits of camphor in the Museum of Odessa. In shape the nondescript appears like a cross between a leech and a lizard, but its tail, like that of a scorpion, terminates in a sharp point. Where it came from—if it had lurked in the fissures of the ceiling, or entered by some secret aperture—has never been explained." Further light is here evidently wanting. If such a creature exists, might it not be the cause of the two mysterious deaths said to have occurred in a mansion in one of the West-end squares?

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

THE BELGRAD DISTURBANCES.

MAY I ask wherein these occurrences differ from those reported as having frequently happened during the Dark Ages, but which were unknown in the earlier half of this century? If fiends, or, as they are now euphemistically* called, Polter Geister, can produce such phenomena without the intervention of a medium, we are plainly mere playthings for evil spirits. For, if the streets of Belgrad are rendered at times impassable by showers of stones, flung by no visible hand, what guarantee have we that the streets of London or Paris may not be bombarded in like manner? If such things cannot happen without the co-operation of a medium, it seems to me that he or she stands exactly in the shoes of the mediæval witches, and is *particeps criminis*. If the fiend is powerless without the medium's aid, but with that aid can work mischief, the medium may surely be regarded and treated as a public enemy.

R. M. N.

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* Our correspondent's term is "beschoenigend," which we are obliged to translate into English as above.—ED. J. S.

NOTES.

We learn that the Institute of Chemistry has obtained a Royal Charter. Consequently the constituents are now entitled to append the letters F.I.C. to their names, which many of them have hitherto been doing illegitimately.

In some parts of Essex a snail is called a "hod-my-dod," even by persons of education, and the wild rose is known as a "Canker."

The "Journal of the New York Microscopical Society" gives a curious list of reputed prodigies, showers of blood, milk, oil, flesh, &c., and bloody springs.

On September 26th the thermometer fell at Paris to 2° C., and in the night even to 0·7°. At the same time the temperature at Moscow was 8°, at St. Petersburg 5°, at Stockholm 6°, and at Copenhagen 7°.

With reference to the destruction of young trout by mosquitoes, it appears that these pests in cold climates are much stronger and better armed than in hot countries; in Newfoundland and the North of Asia they can perforate a leather glove.

According to M. Richet the physiological action of rubidium is similar to that of potassium, but it is less poisonous by one half.

A notion—whether well- or ill-founded we know not—prevails in Turkey that leprosy may be occasioned by a stroke of lightning.

According to Mr. B. Blount certain specimens of copper pyrites, from the County Cork, are so explosive that they have to be rejected by manufacturers of sulphuric acid.

Floating ice has recently been found near the Norwegian coast, in the latitude of Bergen,—a phenomenon of which there is no previous record.

Recent palæontological researches go to show the impossibility of drawing any definite line of demarcation between the Carnivora and the Insectivora.

On August 10th snow fell in the province of Rio Grande do Sul, in Brazil, to the depth of 6 inches. The district is near the coast, and not mountainous.

At the recent meeting of the American Association for the Advancement of Science the Section of Microscopy and Histology was abolished. This is a step in the right direction. Histology is simply a branch of Biology, and Microscopy is a case of "cross-divisions."

Said a lecturer before the Society of Arts:—"When large London estates were rapidly covered with houses, that scourge of London arose—the modern speculative builder. Calculating on a rapid fortune, he invented one house. That one house has been repeated *ad infinitum*,—a forlorn design it is, and the example so profitable to the builder has covered modern London with the dreariest streets to be seen anywhere in Europe."

Mr. A. B. Lee contends that the halteres of the Diptera contain, besides the organs of hearing, other organs of doubtful function.

Dr. Shufeldt, writing in "Science," confirms the experiments of Miss von Chauvin on the tranformations of the axolotl. He finds that the metamorphosis is hastened by abundance of suitable food and by a moderate increase of temperature, and retarded by an extra depth of water.

Whilst cheerfully acknowledging the many services which the late Earl of Shaftesbury rendered to the country, we are bound to put on record our profound regret that he should have lent his name and influence to that deplorable outburst of fanaticism, the Bestiarian movement.

Dr. Rohé maintains that the rate of self-purification in rivers is limited, and may be easily exceeded by the rate of pollution.

[We are not aware that anyone has questioned these propositions.]

Prof. H. Drummond claims for the termite (*vulgo*, white ant) a very important part in the formation of soils in tropical countries.

In the present smallpox epidemic at Montreal the deaths up to a certain date were—Catholics 750, Protestants 35. The Catholics reject vaccination, and the Protestants accept it. The "Echo," a well-known anti-vaccinationist organ, admits that, if vaccination is useless, at least 250 Protestants should have died to equalise the death-rate.

Mr. R. A. Mullan, an Irish solicitor, observed during a recent hailstorm in County Down that some of the stones were decidedly red, and this not merely on the surface. On melting they stained his fingers.

It is asserted in some quarters that H. Milne-Edwards, towards the close of his life, gave in his adhesion to Evolutionism.

Others, however, assert that he died impenitent, a hardened Cuvierian to the last.

We regret to learn that the "Kansas City Review" is in danger of coming to a close for lack of public support. The editor, Mr. T. S. Case, has conducted this journal for seven years at a considerable loss to himself. It will be discreditable to the inhabitants of Kansas if the career of so useful an organ should be cut short.

"The Museum," formerly of Philadelphia, has now been incorporated with the "American Antiquarian."

The superstition still prevails, even in London, that the death or disappearance of a black cat forebodes evil to its owners.

Prof. Brauer divides insects into six super-orders and sixteen orders. He holds that there are no connecting types between the orders now existing, and that the path to a common ancestral form is interrupted in many places.

Among the multitudes who will deplore the premature death of the illustrious chemist Walter Weldon, not many, probably, will be aware that the deceased was an avowed Spiritualist.

The occurrence of native iron, not of meteoric origin, in Greenland, is now placed beyond doubt. It may even become of commercial importance.

It is hoped in some quarters that the death of Dr. Robin, following so soon upon that of H. Milne-Edwards, might effect a reform in the Section of Anatomy and Zoology of the French Academy of Sciences, by eliminating a part of the Comtean and anti-evolutionist element from that retrogressive body. We fear, however, that the influence of the surviving members will dictate the manner in which these vacancies will be supplied.

Literary Announcements.—An important and comprehensive new work for merchants, manufacturers, and others, by William Chadwick, accountant, entitled "The Combined Number and Weight Calculator," will shortly be issued by Messrs. Crosby Lockwood and Co., London. The work will show at a glance on any page (1) any number of articles consecutively from 1 to 470; (2) any number of cwts., qrs., and lbs., from 1 cwt. to 470 cwts.; (3) any number of tons, cwts., qrs., and lbs., from 1 to 23½ tons at 421 different rates ranging from 1-64th of a penny each to 20*s.* each, or per cwt., and £20 per ton; the whole comprising over 250,000 direct calculations, which, with one addition, will produce upwards of twenty-five millions of calculations.—The same publishers also announce for immediate publication, "Electro-Deposition, a Practical Treatise on the Electrolysis of Gold, Silver, Copper, Nickel, Cobalt, Iron, and all other Metals and Alloys, &c., &c." By Alexander Watt.—" The Prospector's Handbook, a Guide for the Prospector and Traveller in search of Metal-bearing or other valuable Minerals." By J. W. Anderson, M.A.—" The Engineman's Companion, a Practical Educator for Enginemen, Boiler Attendants, and Mechanics." By Michael Reynolds.—" The Artists' Table of Pigments," showing their composition, conditions of permanency and non-permanency, adulterations and effects, &c. By H. C. Standage.—A new and revised edition of " Land and Marine Surveying." By W Davis Haskoll. " The Metal Turner's Handbook, a Practical Manual for Workers at the Foot-lathe," by P. N. Hasluck, with over 100 illustrations (being the first volume of Messrs. Crosby Lockwood and Co.'s new series of Handy-Books on Handicrafts).—Also the following works in their popular " Weale's Rudimentary Series " :—" Practical House Decoration." By J. W. Facey.—" A Treatise on Marine Engines and Steam Vessels." By Robert Murray, C.E. New edition, by Geo. Carlisle, C.E.—" Locomotive Engine Driving." By Michael Reynolds. Seventh edition ; including a Key to the Locomotive Engine. — " Stationary Engine Driving." By Michael Reynolds. Third edition, revised and enlarged.—" The Rudiments of Mineralogy." By Alexander Ramsay, F.G.S. Third edition.—" Coal and Coal Mining." By Warington W. Smyth, M.A., F.R.S. Sixth edition, revised.

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THE

JOURNAL OF SCIENCE.

DECEMBER, 1885.

I. THE INTERBOND OF THE SEEN AND THE UNSEEN.

Collated by the AUTHOR OF "SCIENTIFIC MATERIALISM."

(Continued from page 643.)

> "There are more things in heaven and earth, Horatio, than are dreamt of in your philosophy."—*Hamlet.*

PART II.—NATURE'S DIVINE REVELATIONS.

THIS section of the work begins with the *usual* Fire-mist "In the BEGINNING the Univercœlum was one boundless, undefinable, and unimaginal ocean of LIQUID FIRE.[*] This was the original condition of matter:

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[*] Is it possible to explain the meaning of "this boundless, undefinable, and unimaginable ocean of liquid fire" as an imagined presentment, being in fact the effulgence of the primal intelligence? This fine mist, matter, or heat, in the subsequent text is explained, inasmuch as it is stated that motion, matter, and heat are synonymous terms. This fire mist is held as a scientific hypothesis, but this does not make it more a fact. Prof. Tyndall says "Not alone the mechanism of the human body but that of the human mind itself—emotion, intellect, will, and all their phenomena—were once latent in a fiery cloud." Porter ("Science and Revelation") truly says "Observation has never yet reached, or can reach, the development of a fiery cloud into emotion, intellect, will, and phenomena of the human mind." With all deference to the originators of the nebulous theory, out of which this fiery development has arisen, I do not believe in its possibility; it is beyond the bounds of all reasoning; there is no proof of it; induction and deduction are equally at fault. What evidence have we? The plutonic rocks! The compression of substances elicits heat, and so the piling of substance on substance is sufficient

"without form, an eternity of motion; without parts, unparticled; an Eternal Sun, without beginning or end, it was a vortex of one Eternity, an infinite circle, the essence of all power; its constitution was not to develop forces, but Omnipotent Power."

"Matter and Power existing as a Whole, inseparable." "The *matter* containing the substance of all Suns, Worlds, and systems of Worlds, with qualities to produce all things existing thereon," producing "Motion, Life, Sensation, and Intelligence, to be impartially disseminated on their surfaces as Ultimates."

"This great centre"—this Great Power of Intelligence, this Great Germ of all existences—was one World, containing the materials and Power to produce all others," with "Wisdom equal to Matter to plan and direct their . . . movements." Its whole "principles were joined into one vast *Vortex* of *Pure Intelligence*."

The whole mass of Matter was as "liquid lava"; the elements then developed were Light and Heat. The Power contained in this great vortex was the GREAT POSITIVE MIND, and its development ETERNAL MOTION: so Matter and Motion constituted the original condition of all

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to account for the modern state of the primitive rocks, without the outrageous idea of liquid fire being the origin and commencement of all things. The heat of the compacting mass, as its materials lay closer and closer, would lose much of its bulk, and consequently of its heat, causing foldings and elevations as layer after layer was thrust out of place, and hence the catastrothisms we read of. What has Chemistry to say to such a state? The whole of space filled with liquid fire, combustion; and of this combustion, what would be the results? The elimination of the elements, or a resulting residuum of uncombined dust? a mass of an unintelligible something. Cosmic dust? of which some of our wonder-working scientists have been so eloquent on. Cosmic dust! or cosmic fiddlesticks; they know as much about the one as the other. An appeal may be made to the flaming hydrogen and nitrogen, the flaming photosphere, and other illogical scientific hypotheses. If, as the spectral analysis proves, all orbs are constituted of the same material, then we must fall back on our Earth—the only orb which we can intimately know. Where is the flaming hydrogen and nitrogen, and fiery photosphere? The brightness of the Sun can be accounted for by magnetic effulgences, a more likely hypothesis; and the elevation and almost immediate collapse of towering flames, volcanic eruptions, and flame floods, glowing lava,—a liquid fire absorbing space,—is a chimera, and worse; it is a chimera enveloped in an absurdity. This fiery furnace is the result of the "scientific imagination" which some of our sensational scientists are so prone to indulge in. "What we groan under is not the tyranny of thought, but the dogmatism of assumptions." "Who are the charlatans? all men who give reproof to the ages by presenting systems in advance of established crudities." Tertullian wisely said "Time is the ally of truth, and wise men believe nothing but what is certain." Goethe tells us "Every bird has its decoy, and every man is misled in a way peculiar to himself."

things. "Cause and Effect were involved in *one* Universal Motion."

Matter, Heat, and Light was the primeval condition of all substance. Its ultimate purification would produce the peculiar essence of animal life and intelligence. From the lowest this was a sphere of progression, "a constant development of inherent principles and laws, the lower containing the higher, and the perfected comprehending all below it. The perpetual vortex was the Spiritual, the perfect and spontaneeus substance of the *Great Positive Mind*."

Matter could not "exist without a principle of inherent and Eternal production." "It was impossible for this . . . Positive Power to exist without Matter as its accompaniment and vehicle: that this Matter might assume *forms* the action of the Great Positive Power was necessary to impel it to higher states of progression. Matter thus acted upon was developed until it became an external *Equilibrium* or *Negative*" of the power acting on it. "Thus Positive and Negative" were established, and "Matter was thus obliged to obey every impulse or force given it by the internal principles emanating from the Great Positive Mind."

"The Great First Cause, or Vortex of pure Intelligence, was a *First* or *Cause Internal*.* Matter,† with its properties, &c., may be termed a *Second* or *Effect;* and the external or countervailing force, developed by the action of the internal, was a *Third* or *Ultimate*. In the beginning GOD created—or the *Great Positive Mind* caused"—all "existences and forms."

The lecturer then shows how an incalculable number of Centres or Suns were produced by the condensation of heat and light: from these proceeded planets revolving around their controlling centres, "and so an endless circle of suns and formations were produced corresponding to other circles, each circle bearing an eternal system, and an index or symbol of the Great Sun or Focus." Five circles of "Suns and systems of worlds" were produced. The *sixth* circle are Suns only, "pursuing their indefinable orbits in the form and composition of *blazing Comets.* The Great Centre from which these emanated is an exhaustless fountain of never-ending materials; it is a Centre around which all Suns and Suns of Suns revolve." It is a vortex, "an everlasting and unchangeable Parent of all things." It is a Germ which developes its inexpressible attributes throughout the vast Univercœlum and Eternity.

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* In the Vedic poems of Chaos or the Beginning: "Nothing that is was then; even what is not did not exist then. What was it that hid or covered the existing? What was the refuge of what? Was water the deep abyss, the chaos which swallowed up everything? There was no death, nothing immortal. There was no space, no life, and lastly no time. No solar torch by which the Morning might be told from the Evening. That one breathed breathless by itself; other than it, nothing has since been. That one breathed and lived; it enjoyed more than mere existence; yet its life was not dependent upon itself, as our life depends upon the air which we breathe. It breathed, breathless. Darkness there was, and all at first was veiled in gloom profound as ocean."—(*Hist. San. Lit.*, Max Müller.) Talboys Wheeler says, in the "Vedas," as a prevailing idea, "There is the expression of one Supreme Being in all and above all."

† Mr. Fishbough, in a note, says that in speaking of the original condition of things the lecturer used Matter and Fire as synonymous.

Then follows a repetition of the formation of Suns, &c., until our own Sun is arrived at, and the formation of the planets, which, in accordance with their nearness to the Sun, are more dense. All the systems of Suns are but one system, as all is "but one general Evolution of Worlds from the Great Centre, and therefore but one Infinite production from one Eternal Origin."

"The human mind cannot conceive of Eternity or Infinity, being limited in its nature, belonging to and produced by finite forms, and existing among transient things,"—"but in its sparkling brilliancy the imagination will pass off into infinite space, and, not being able to perceive limits, it becomes confused and bewildered. Although it may contemplate the sidereal heavens, their circumferences, their diameters, and revolutions, and meditate upon their compositions and combinations, and endeavour to conceive the geological formations of each as they were successively developed from the first condensation of particles into worlds, all its conceptions would be *limited*, and could not give *the least possible idea of infinite space.*" However, possibly it might be but one system with various formations.

The elements that were successively devolved from the Great Centre which contained them were Heat, Light, and Electricity. Heat was an emanation from fire; and the light produced from heat, by its becoming less particled and more rare, was so sublimated and refined that its ultimate was, and is, that all-pervading element *Electricity.*

There is not so much electricity in the Sun as amounts to a positive attractive power, nor such a thing as positive repulsion produced by principles of like nature. Motion is neither produced nor sustained by any such actuating principles; neither is anything, formed or organised as an effect, produced by positive opposites; for if "a substance could be produced in this way it would be existing in a *vacuum,* and between two antagonistic principles." Hence there would be no motion, action, exchange of particles, neither increase nor diminution, a destitution of all life or usefulness; instead of opposites, there is harmony in all formations: both are immutable in their adaptations, the one to form and the other to constitute the materials of the formation.

The meaning of attraction, gravitation, and condensation is an *association of particles possessing mutual affinities.* There is a refinement of inherent particles in all bodies, and a constant passing off "of those particles which have become too refined to continue an association in the same composition."

"The constant attraction existing in all bodies in the vast system of planetary worlds is owing to a mutual gravitation from each of particles that have become fitted to associate with the composition of each and of others. And thus Worlds, and Worlds of Worlds, were made, and thus sustained." "And thus the Eternal Laboratory will produce and reproduce until all things and substances shall become rarefied, refined, and perfected, and until they all gravitate to spheres of *celestial* attraction and *spiritual* association."

Electricity (a negative to the internal Positive Power) pervades all space, penetrates all substances, exists throughout all worlds. Every particle in the realms of infinite space contains in its composition unparticled Electricity.

"The great *body* was an *atmosphere* or *halo* surrounding the Great Centre, or Sun, eternally existing; and Heat, Light, and Electricity were successive developments of this great mass." "These are the only principles in existence; all other things are mere *modifications* of these principles;" *everything has its own peculiar atmosphere, and consequently its specific and necessary association.*"

"The *Spiritual Principle*, or destined *Ultimate* of all things in existence, will be a *Negative* to the Great *Positive* Mind, and between the two will emanate *new worlds*, an epoch of another BEGINNING."

"The great fiery ocean of chaotic matter that has breathed into being the *Grand System* of worlds . . . was a universal *Exterior* or *Form*, and a Vehicle of Power, that radiated from *the Internal.* It was a Form produced by the *Invisible* yet *real existing Principle—the Infinite Mind.* Therefore the Great eternal *Interior* and the Great eternal Exterior constituted the only Principle and Form in being."

The causes by which Space was filled with systems of Worlds were established "by the force and spontaneous action of the *Will* of the Eternal mind. The Will (as an effect of the Infinite Mind) as an executive power was the first Cause of all things." "Every particle in being is constantly passing through *Forms*, *Orders*, and *Degrees*," each "unceasingly seeking association and equilibrium." Every association of atoms, large or small, "has a previous correspondent." Every "correspondent is a type, symbol, and representative of higher and more perfect spheres," but all in an advanced stage of progression. General and special interferences are seemingly existing when things are *particularly* and *minutely* considered; but when the *great System* is considered as a whole, *harmony* alone is visible, and is a *true correspondent of the Vast Universe*, and the whole thus existing receives "the tranquillising influence of DIVINE LAW." *

Solar System.

The Sun, the centre of our system, is but a remote planet of another system existing prior to its formation. The Sun has two motions; one on its axis, the other in its orbit, around a greater centre. Eight planets are determined on; but the *eighth* and *ninth* are not recognised as belonging to the Solar System.† The Sun's atmosphere extended to the orbit occupied by the ninth planet, or rather cometary body. Electricity was the agent by which a transfer was made of molecular substances to new stations.

Then follows a long comment upon the nature of motion and its action upon planetary arrangement, and a description of the *nine* planets, their magnitudes, atmospheres, motions, with the motions of their satellites. He gives the eighth planet, Neptune, six, Uranus six, Saturn seven, Jupiter four moons (no mention is made of those of Mars). He says that the ninth, eighth, and seventh planets are uninhabited. A description is given of the surface appearances, vegetation, animals, and man, in each of the others. The asteroids, which he states are *four* (Ceres, Pallas, Juno, and Vesta), are portions of a planet, "*thrown asunder* by an incomprehensible expansion of interior elements."

The general astronomical dicta are generally in accordance with the attainment of the science of 1846, the eighth and ninth planets excepted.

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* Mr. Fishbough, in a note, says the Clairvoyant incidentally said Man was the only being who has pursued a course of isolated and selfish action, governed by laws which never did and never can exist in Nature, or in the plans and institutions of the Great Mind.

† This was March 1846, months before Le Verrier's conclusions had been announced in America (*vide* p. 161).

The Origin and Beginning of the World.

The mythology of primitive nations contains inconceivable conceptions: some that the world assumed its present form and condition in an instant of time; that it was supported in its position by gigantic beings, each supported by others still more powerful, until supposition lost the foundation on which they stood in the realms of fancy and imagination. The opinion reigned, until a few centuries past, that it was perfectly immovable and flattened on its surface. At this time superficial Theology reigned with all power and authority. He who presented a truer conception was nearly sacrificed on the altar of bigotry and superstition. At length the true system of the world, by slow gradations, was exposed. Others supposed that from an incomprehensible *nothing* a tangible *something* was created.

The struggle between Theology and Philosophy continued for a long period. Philosophy struggled to overcome the obstacles thrown in its path; at length it became unchained, and emancipated itself from the thraldom which oppressed it. This World has given birth to all the thoughts conceived by man concerning the constitutions of things: the theatre of human action, of pain, of pleasure, of life and and death, of knowledge and ignorance. The Earth and Nature and her laws have given existence to man, endowed him with faculties and sensibilities, and stamped upon him the impress of Eternal Design, and manifested the laws by which his organism was produced. These are the truths yielded to intelligent seekers.

Man abandoned Nature and reason in search of something unwarrantable, and thus lost sight of the true relations between Nature and Science, and of Science and himself, and so degraded became his condition that thought and feeling (language being inadequate) alone could supply the place of expression. Such was, and to a certain extent still is, the condition of things in a world where Nature put forth its energies to yield happiness to the race of man.

A mass composed of atoms and particles previously constituting the atmosphere of the Sun,—the whole held in appropriate position by mutual relations, the result of the supposed laws of attraction and repulsion,—the whole mass being in a state of igneous fluidity, rotary and orbicular motions were established. The rotary motion by the impetus of particles rushing into it, and the revolutionary motion in an elliptic orbit, having an aphelion and perihelion in contraposition to the Sun, was an effect produced by the *general* impetus given to it,—by a perpetual application of the forces producing rotary motion. Reasons follow why the mass should be igneous and why fluid, in accord with the general theory.

The surface of the mass was gradually and imperceptibly relieved of its heat, and by shrinking and condensation the surfaces became united by an elastic coating; eventually granite was developed, with surface uneven—made more so by catastrophic and volcanic eruptions owing to the pent-up interior heat. These eruptions caused immense valleys, containing seas of great depth. At this time almost the whole surface of the Earth was covered by water, by the action of which the rocky prominences were worn down. The water of that period was not composed of the same elements as it is now, because it was impossible for oxygen and hydrogen to have been developed in sufficient quantities in combination to produce these oceans.

Oxygen composes a great part of the Earth's crust. Nitrogen greatly pervades Nature. Hydrogen is intermediately active in many substances. Fluorine is an ultimate of nitrogen and hydrogen in combined states. (Carbon in some forms, yet not so extensively as in other elements). There is not existing in Nature any composition which does not contain some or other of these elements, and it is impossible to find them *totally* disconnected.

As to the possibility of dividing Matter into atoms—Matter, including its elements and principles, is joined by association: this shows the impossibility of reducing particles to their ultimate state of disconnection.

"There is a diversity in the attributes and motions of imponderable elements." "For ages these principles have been producing phenomena before the eyes of the world." It is only now (April 29th, 1846) the dia-magnetic principle was discovered,—a great agent in cosmic relations.

The atmosphere which enveloped the pulsing mass in specific gravity was not much less than that of water now existing. No substance yet formed contained elements which did not exist in the primitive formations: the first sedimental stratum followed as a sole consequence of the action of the waters against the ejected rocks, and neither in this nor in the previous formation are any Infusoria or marine polypi, so largely manifested in succeeding formations. Thus granite and the sedimentary rocks may be considered as the primal coating of the igneous mass.

Then follows the formation of different strata, fitting the whole as a receptacle of life. "First there is an *Embryo* of all other existences,—a *Germ* containing the essential properties to produce higher states of refinement. The very moment that the first particle woke into life, from that moment Life, Sensation, and Intelligence were determined as inevitable and endless results. Life is a progressive development of the principle of *Motion*. Marine plants were the first forms suited for this development." "The whole creation, from the highest to the lowest formations, has proceeded in an order of succession so as to exhibit a general correspondence between Geological and Zoological formations."*

"The substance in granite known as quartz, the most perfect compound of oxygen and silicon combined with limestone in which carbon was extremely condensed, by the union of these and the heat generated thereby, acting with the favourable affinities of the water and the atmosphere, created in some portions of the sea's beds and from partially protruding rocks, a composition assuming apparently the state of rest, while in reality the imperceptible motion existing in it was decomposing and uniting particles, and creating a principle of internal vitality, or *vis vitæ*."

Thus "was breathed into existence the forms termed flowerless and marine plants, the highest type of which is the *fucoides*." Then follows a description of the succession of the forms of life, till the vegetable development of the grauwacke and clay, classed as *avertebrated* because sensation had not yet become a distinct principle." "The term sensation as applied to life, vitality, or a minute degree of motion, is improper. Sensation is as distinct from life as life is from motion. Sensation is the principle which connects the inner life or spirit with the external body."

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* According to Barry O'Meara a curious illustration of evolution ("Napoleon in Exile," vol. i., p. 198) was delivered by Napoleon:—"There is a link between animals and the Deity. Man is merely a more perfect animal than the rest. He reasons better. But how do we know that animals have not a language of their own? My opinion is that it is presumption in us to say No, because we do not understand them. A horse has memory, knowledge, and love: he knows his master from the servants, though the latter are more constantly with him. I had a horse myself who knew me from any other person, and manifested, by capering and proudly marching with his head erect when I was on his back, his knowledge that he bore a person superior to the others by whom he was surrounded. Neither would he allow any other person to mount him except one groom who constantly took care of him, and when rode by him his motions were far different, and such as seemed to say that he was conscious that he bore an inferior. When I lost my way I was accustomed to throw the reins down his neck, and he always discovered it, in places where I, with all my observation and boasted superior knowledge, could not." (*What a nut for Romanes had he but known this anecdote!* It is a better illustration of the intellect of animals than an educated oyster.) "Who can deny the sagacity of dogs? There is a link between all animals. Plants are so many animals who eat and drink, and there are gradations up to man, who is only the most perfect of them all. The same spirit animates them all in a greater or lesser degree."

Tides.

The theory of tides presented by the scientific world is "generally very incorrect." "It has been supposed by a conspicuous astronomer that tides were produced by the law of *attraction*—by the action of the moon upon the earth. This cannot be true; for attraction is not an established principle, especially beyond the atmosphere of any body or substance." "If the moon has any attractive influence upon the earth (more than what consists in the natural relation existing between the two bodies), why, when the moon is in conjunction with the sun, does not the water become *more elevated* on the side of the earth next to these bodies, as might be expected if such attraction existed? Also substances on that side of the earth would not weigh nearly so much as when the moon was otherwise situated. Also when the moon is on the opposite side of the earth, and the earth sustains a position between it and the sun, why is not the elevation of the water *equal* at all portions of the earth? For if the moon and sun exert an equal influence, the results should be an equal height of the water all over the earth."

"The falling to the earth of a substance previously suspended in the air has been termed *gravitation*. The tides have been considered as the result of the same principle. All things have been represented as possessing to a greater or lesser extent the principles of attraction and repulsion—a perfect and established *antagonism*. And, inasmuch as this belief is extensively prevailing, it is not possible that a different theory or hypothesis can be received unless it addresses the understanding of man with more plainness and cogency than the former theory."

"It is a well-ascertained truth in astronomy, and in the principles of mechanics, that a body rotating like the earth on its axis has the greatest tendency to throw off substances in the direction in which it revolves. As the earth revolves from west to east once in twenty-four hours, it must necessarily produce two elevations of water, especially as the water surrounds the whole globe. Every twelve hours the water would be elevated at the extreme east and the extreme west, or, in other words, at given antipodes of the earth. The elevation of the water once in twelve hours is a result of the centrifugal tendency that the globe creates in one half of its period of rotation, corresponding tides being thus produced on the opposite sides of the earth. There are many things operating incidentally upon the water which produce variations in the periods and elevation of the tides in different places on each portion of the earth. A correct knowledge of the law of fluids will at once demonstrate the cause of the whole phenomenon, and it is by understanding the natural tendency of fluids, and that of all other substances, when subjected to a centrifugal force, that the present explanation of the phenomenon will become established beyond the possibility of refutation.

II. SANITARY AGENCY OF LIGHT.

THE discovery of M. Duclaux described in the last number of this journal for October under the above title would seem to be a necessary corollary of the facts made known by Downes and Blunt in 1877 and 1878, and embodied in two papers read before the Royal Society, and entitled respectively "On the Effect of Light upon Bacteria and other Organisms," and "On the Influence of Light upon Protoplasm," the conclusion being stated as follows, "Light is inimical to, and, under favourable circumstances, may wholly prevent the development of these organisms, its action upon Bacteria being more energetic than upon the mycelial and torulaceous fungi, which are prone to appear in cultivation fluids. The author went further, and showed that this effect was due to oxidation, which, so far as protoplasm and certain other substances of organic origin were concerned, was stimulated by light, and ended either in the extinction or great depression of the vitality of organisms submitted to it. Moreover they succeeded in localising the action in the spectrum, their conclusions being thus stated.

"It is probable, therefore, that if the phenomena were represented by a curve, the maximum elevation would be found in or near the violet, a rapid descent occurring in the blue or green, after which the line of curve is maintained more or less as far as the visible red;" in other words, the effect is produced by the more refrangible rays, and may be classed with the chemical phenomena of photography. The sanitary aspect of the subject is only a particular application of a far-reaching law, including probably all animal and vegetable life; and the results of it, so far as botany is concerned, have hardly received the recognition they deserve.

There is a simple experiment in illustration which anyone may make for himself, and which is highly suggestive. Let a bean be put in a little water at the bottom of a tin canister with the cover on (a mustard tin will do well), and kept a day or two in a warm place; on removing the lid, it will be found that the plumule of the seed has shot up into a long, straight, succulent stem. Now make a hole in the tin in such a position that light may fall through it upon the stem about one third of its length from the top. It will be found that the shoot gradually bends over towards the side where the hole is, the curve beginning where the light falls; if a longitudinal section of the stem be made, and examined with a low power under the microscope, the cause of the curvature will be clearly seen. On the concave side the cells are shortened, thickened, and generally huddled together, so that the top has been drawn down towards that side, the effect being evidently due to the check imposed upon the growth of their protoplasmic contents by the action of the light. Whether the thickening of the cell walls implies an increased growth of cellulose (or woody matter) is uncertain, but it is more probable that it is due to the spreading of the same amount of material over a smaller surface. It is to be specially noticed that the bending of the stem, and the thickening of the cells, precedes the appearance of a green colour, which, however, soon follows if the exposure is prolonged.

This little experiment throws a flood of light upon a large class of obscure phenomena connected with the growth and habits of plants; it shows why "etiolated" specimens (*i.e.*, plants grown in the entire or partial absence of light) tend to become spiry, and to throw out lengthened shoots; it will account, too, for many of the observed facts of "heliotrophy"—the turning of plants towards the sun or light—which have previously all been regarded as purely vital phenomena. We seem, also, to get a glimpse at the meaning of the appropriately named "pileus" or cap of a numerous class of fungi represented by the common mushroom, under which the delicate highly-vitalised spores are stowed snugly away out of reach of the light. We find out, too, why the delicate Œthalium, or "flowers of tan"—a fungus of another class—creeps away during the day and hides itself in the shade, as it is well known to do. In fact, there is a large number of phenomena in the vegetable world, isolated before, which group themselves together under this law, and acquire a significance which they previously wanted.

It is impossible, however, to contemplate this aspect of the action of light in the natural world without having another and a very different one forced upon our attention. If we continue to expose our long white bean shoot to light we find that it becomes *green*. This result, as is well known, is due to the production of chlorophyll, and is the commencement of true growth in the sense of increase, for before the shoot contained nothing but what it obtained from the parent seed and the water in which it was placed, now it is beginning to "shift for itself," and provide its own nutriment from the surrounding air. Now, it seems very strange at first sight that the same white light should promote growth and increase on one hand while it checks and stunts it on the other, but the explanation lies in the nature of white light, which is not one and indivisible, but is made up of rays of many refrangibilities. We have seen that the power of injuring white protoplasm lies chiefly among the more refrangible rays represented by the blue and violet, but it is the yellow and red rays at the other end of the spectrum which produce chlorophyll. And here we come upon another remarkable contrast; the rays at the violet end of the spectrum check vegetable growth by promoting oxidation, those at the red extremity afford nutrition to green plants by promoting de-oxidation, at least in the special case of carbon dioxide, and very probably of water also.

It is not meant to imply that there is a sharp line of demarcation in the spectrum, at either side of which oxidising or de-oxidising influences exist, but that such influences predominate at opposite extremities, the peak or maximum of the curves representing them being thus situated, the declining lines of the curves crossing each other at a neutral zone. Here again we come upon a pregnant fact; the neutral zone of the spectrum, where the curves intersect, and where oxidising and de-oxidising forces both disappear, is situated at or near the *green*.

In the paper alluded to at the commencement of this article, the authors mention "Special colouring matters which filter out the more injurious rays" as one means of protection afforded to protoplasm in the organism, it is clear that there is here an allusion to chlorophyll, though probably some phenomena in the animal world were also in the writer's mind; the green colour of leaves and plants does undoubtedly protect the delicate protoplasmic cell contents from the injurious action of sunlight, by filtering out the rays of higher refrangibility. The subject is a highly interesting one, and might be pursued much further, but sufficient has been said to show that the influence of light upon protoplasm involves results of the deepest moment in the vegetable, and probably also in the animal world—results which would well repay further investigation, and, even in their practical application, are probably by no means confined to "Sanitary agency."

III. INDIAN STEEL.

By L. D'A. J.

ALMOST every province of India has produced malleable iron from a very early period, even when the rest of the world was going through a bronze age, or perhaps also part of a stone age. The Dehli Láth—a pillar of very pure malleable iron without visible weld, 24 feet long and 16 to 12 inches in diameter—was probably made about A.D. 400, and remains rustless to this day, as a monument of the skill then available.

The iron industry of India is now nearly crushed out, partly by English competition and partly for want of fuel, the vast forests of India having apparently been consumed by the people for domestic purposes, as well as for iron manufacture. All revivals of this industry can only be partial and local.

Steel manufacture of a high class would not, however, meet with the same impediments and difficulties, as tool-steel must always command a relatively high price, and be able to bear a high cost in fuel and in labour. It may be interesting, therefore, to mention the places where *wútz* was formerly manufactured, and the conditions as far as are now known, though many of the details have always remained secret.

The chief object of the human race in all countries, when commencing steel manufacture, was to produce good sword-blades and fish-hooks.

Our forefathers, the Danes, appear to have used swords of two sorts in their earlier period before the conquest of Anglo-Saxon England, and even before their earlier successful buccaneering expeditions into Rhineland, Frankland, and Neustria. The Eddaic poems, both Mythologic and Heroic, refer to the "yellow gleam of the falchion" as well as to the biting iron and the steel blade, valued at a chief's ransom or a chief's daughter's dowry, when the master of fighting men carried spears and shields. Such swords had names, as Brîmir (Grimnismal), and were carefully proved (Hávamal). They were capable of severing the head from an ox, as effected by the Lord of Goats, Thor, or Jack the Giant-killer, in the Hymiskvidha, and are specially mentioned as made of steel (Hyndluliodh), at a time when the ploughs and sickles were probably of malleable iron, and an iron chest with locks, and even an iron bridge of some sort and unmentioned size, was known to exist.

Before quitting this branch of the subject let us also notice the references in the later Eddaic or Heroic poems.

The sword of Völund, Weland, or Wayland, was a skilfully tempered blade (Völundarkvidha), and not a mere piece of ornamental jewelled smith's work, Völund being a Finnish prince of Ulfdal, Sweden.* A certain sword was specially known by repute (Helgakvidha) among a set of forty-six: it would pierce shields, which at this period were of malleable iron, or partly so. A special spear (probably steel-headed) is borrowed for an occasion. Segurd's sword, named Gram, cuts through Regin's anvil, and cleaves a piece of wool in water; Regin and Fafuir have both named or reputed swords. Guthorm, or Gorram, is cut asunder below the arm-pits by a thrown sword (Gram). After this, however, the keen-edged iron is mentioned (Sigwrtharkvidha Thirdhja); and a sworded and helmed host is distinctively a prince's following,—that is, a group of nobles and gentlemen, jarls and thanes, in distinction to the hûs-carls, churls, and thralls, who carried other weapons, bows and spears generally.

The valuable sword-blades of this period were Walish (Oddrûmargrâtz), either in the sense of Hunnith as then understood, or possibly from Gallia,—Wales itself,—or the Pyrennees; but Gunnar, the Gothic chief, boasted (perhaps untruly) of owning swords better than all the Hunnish ones (Atlakvidha).

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* We may here notice that Völund was a princely goldsmith and jeweller—not a jewel-monger or tradesman, but a craftsman: much of his gold and jewels probably came by some course from India, and, if so, also his best steel, in the form of the present muffin-shaped ingots, or *kurs.*

From these and other collected allusions it appears that during the first five centuries after Christ, or rather after the migration of Odin to Denmark (70 B.C.), the best swords of North European make were Finnish, or made by subject races, the Finns, for their masters the Danes. During the latter five centuries, after the invasion of Attila (433 to 453 A.D.), the best blades were first Hunnish, of perhaps semi-Oriental origin; and at a later period, when Oriental commerce passed through Constantinople and across Europe to Denmark, the sword-blades were truly Oriental, while the ornamentation and hilts were of semi-Roman type, as proved by unearthed specimens from tombs. In the Early crusading period Damascus blades were superior to anything before made.

There is hence proved a successive tendency over centuries to obtain better sword-blades invariably from the East, and culminating in the Damascus blades, so called, of the time of Saltán Sálakuddin.

Since that time the tendency has been steadily downward, arriving at last at the London outfitters' regulation sword, made for trade profit and unfit for use in action.

But reverting to Damascus blades: these nominally came from Persia, but actually from India. We learn from the "Ain-i-Akbar" that Persian traders from Isfahán were, in the time of Abbas, in the habit of going to the Indore, and to the Nirmal Steel-mines in the then province or Subah of Barár, superintending the steel-making operations, weighing the proportions, testing the toughness, and taking the *wútz* steel to Persia, where the ores could not produce the same qualities. It is probable, therefore, that there were also other unmentioned places in India supplying Commerce with steel, not only then, but for many centuries before; or, in other words, India had always supplied Europe with the *best* steel, at least since A.D. 400, when the Dehli Láth indicated a high pitch of excellence in metal working, and probably since the Odinic migration (B.C. 70), or before it.

The term Wútz being now, and perhaps always, distinctive of a special best steel, for which the generic term is *aspat*, or *ispat*, it is necessary to notice that the word itself is Telegu, indicating the ancient Telingana, Eastern Haidarabad, or Subah Warádh or Barár (all of which are identical territories) as the chief seat of manufacture, of which the neighbourhood of Nirmal is a part. We have also a certain amount of modern and recent information as to wútz manufacture, which is not quite extinct.

Superior steels, including wútz, were formerly made from the ores of Bajaur, near Peshawar, and in Kachh; probably also in Assam, where large cannon were made, and in Gualior, Bijawar, and Indor: these places and provinces comprise the whole of the seats of old steel manufacture in Northern India that are now known.

In Southern India the probable seats were Palaman (Bengal), Jashpur and Gangpur, Madgole, Sambalpur, Narsingpur, Surat, and various places in the Konkan, Haidarabad territory, Satara, Maisur territory, Kadapa, and perhaps several places in the extreme south of the peninsula.

The essential points in wútz-making seem to have been the use of iron of two ores, one magnetic sand, or magnetite obtained by mechanical separation from rock, the other a rich laterite; an enormous amount of fuel, perpetual reconstruction of furnaces, certain charcoals, and leaves and roots of certain plants; possibly also small quantities of some flags and fluxes. Some of the charcoals used were—Bamboo charcoal, sal (*Shorea robusta*), bijasal (*Dipterocarpus marsupium*), mhawa (*Bassia latifolia*), teak, dhao (*Conocarpus latifolia*) and ker (*Acacia catechu*); also green leaves of the *Convolvulus laurifolia* or *Ipomea*, stems of the *Cassia auriculata*, and leaves of the ak or madar (a large Asclepiad, *Calatropis gigantea*), as well as the charcoal of its roots.

In olden times, when fuel was plentiful, the chief requisite was evidently the magnetic iron sand, or magnetite, capable of mechanical reduction; and apparently it was also indispensable, while much of the rest may have admitted of substitutes under some variety of treatment. There are doubtless theories that some special excellence may have been locally due to amount of protoxide of iron, to manganiferous or titaniferous ores, or to slightly calciferous ores; but none of these are fully proved. There may have been some special secrets of treatment or manufacture, but everything points to excessive purity of iron, judicious blending, and selected charcoals, as the chief matters on which general excellence was based.

In India magnetite occurs in beds or veins, in metamorphic or gneissic rock, also in transition rock, and in Dakhan-trap; apparently not in other formations to any large extent, excepting the black iron sands, or magnetic iron sands, formed by natural disintegration from the older rocks, without any chemical transformation of the iron. The only substitutes for this iron, in pure flakes or grains, seem to be pisolitic and subnummulitic concretions, which are frequently very pure and unaltered.

The other element in steel or wútz manufacture is personal metallurgic skill. In India this appears to have been one of the qualities of the old races, or so-called indigenous races, the Kols, Gonds, Santals, Aguriahs, &c., as distinct from the otherwise superior races, the Low Hindoos, and the Kshatri, Rajput, and Brahman of the Upper Hindoo race. We find the analogy in Europe: the good metal-working races having personal skill were the Finns, the Biscayans, the Silurian, and Cornish; while the Angles, Saxons, and Danes have, in their larger operations, trusted to extensive mechanism and systematic management, reducing the worker to a mere mechanical unit. This is a mode of obtaining large results, under a routine, with a fair average in quality at a small expense, but it is not the way to attain excellence in detail; it is, in fact, the principle of democracy as opposed to aristocracy, when applied to work and progress.

If the steel manufacture is to be re-established in India, in its former splendour, the old principles must form the basis of action, while the scientific powers of the English must aid in direction and forecast.

The enormous mineral wealth of India, chiefly Southern India, in the form of magnetic iron, is a matter about which no doubt exists. Salim and Travankur could alone supply Europe for many centuries. As to the general distribution of iron ores that occur in abundance and workable quality, or have been already worked at various places, the author has compiled the following table from data in Ball's volume on "Economic Geology" (London, 1881), the arrangement being in accordance with the classification adopted elsewhere in his own books. This table supports the statements already made on the subject of steel.

London, October, 1885.

THE IRON ORES OF INDIA.

North-Western India.

Afghanistan.—Iron ore imported from Peshawar.

Derajab, &c.—

1. Kanigurano: limonite, in shales below nummulitic limestone, black and magnetic.
2. Bannu: earthy hæmatites, in nodular masses.
3. Bajano (near Peshawar): black magnetic iron sand; steel used for gun-barrels.

Sind.—Lainyan (near Kotri): local masses of magnetite; bands of red and brown hæmatite.

Punjab.—

1. Mundi: iron sands.
2. Kohad (Kangra): magnetic and micaceous ores, in metamorphic rock.
3. Kot Kerana (Ihelam): hæmatite.

Rajputana.—

1. Bhangarh and Rajgarh (Alwar): ores consisting of a mixture of limonite, magnetite, and oxide of manganese.
2. Kerwar (Jaipur): large old mines.
3. Gangar (Udepur): ores in a bed of limonite with associated psilomelane.

Guzrat.—

1. Palanpur (Pauch Mahals) and Narukot: old mines.
2. (Ahmadabad) Gogha: old iron-works.
3. Ranawao and Ranpur (Kathiawar): lateritic ores, yielding 40 per cent.

Kachh.—Bachan, Lunva, Dudhai, Madh, and Vibroi: sub-nummulitic lateritic ores, also ferruginous deposits; *wútz* formerly made.

North-Eastern India.

Sirmur.—Chaita (Nahan): magnetite, probably mixed with specular ore.

Gurgana.—Firozpur: brown hæmatites.

Kumaon.—Ramgarh: micaceous hæmatite.

Nipáland Bhutan.—Unknown.

Assam.—

1. Impure limonite from the Sub-Himalayan strata.

2. Nodular clay-ironstones, and thin beds of it, at Tirugaon and Tel Pung-Brahmaputra Valley, in Upper Assam, yielding 22 to 40 per cent of iron. Old manufacture of large cannon in the 16th century: metal 7¾″ thick; gun 17 feet long.
3. Pandua: iron ores, magnetic.
4. Cherrapunji: iron sands, composed of minute crystals of titaniferous magnetic oxide, obtained by surface raking of partly decomposed granite. It is suitable for making *wútz*, knives, and hooks.

Bahar and *Bengal.*

Birbhum.—Partly earthy and partly magnetic oxides of iron disseminated in soapy trappean claystone, at Ballia, Deocha, Dunora, and Goanpur; an ore containing 46 per cent of iron, up to 60.

Monghir.—Bhimband (Karakpur Hills): lateritic ores, and thin bands in schists.

Raniganj.—Ironstone shales between the coal-bearing strata (Raniganj and Barakar groups), yielding 24 to 69 per cent of iron in ore chosen.

Manbhum.—Small quantities of magnetic iron-sand; ironstone shales and ferruginous concretions from shale-beds and sandstones; bedded magnetites on the Kasai.

Hazaribagh.—Ironstone shales.

Rewah.—Ore from Coal-measure rocks in Singrauli, and at Hindawa.

Bundalkhand.—

1. Lower lateritic ore near Simereah.
2. Red hæmatite, subcrystalline from the Bijawar series of rocks.

Gualior.—Manganiferous red iron ore; magnetic ores; manganiferous brown iron ore: siliceous hæmatites: all extensively worked in ancient times.

Banda.—Old mines at Goharbai, Deori, and Khirani.

Lalatpur.—

1. Sulda: pure hæmatite.
2. Pura: ores, steely, and yielding kheri.

Bijáwar.—Ancient large manufacture at Hirapur.

Panna.—Old mines.

Indor and *Malwa.*—Old steel-mines mentioned in the Ain-i-Akbari; present information none.

Southern India.

Bengal, part of.

Lohurdugga.—Laterite and beds in metamorphic rock.

Palamao.—Pure magnetic ore and decomposed altered ore, from metamorphotic rock; bedded shales of siderite (black band); concretionary masses of limonite and brown hæmatite, also red hæmatite, from the Barakar group of Coal-measures; bands of red and brown hæmatite in high level; laterite capping the plateau: yielding 33 to 56 per cent of iron.

Singbhum.—Manganiferous ores in lodes near Chaibassa; lateritic ores; pure hæmatites associated with trap; ferruginous schists.

Orissa.—Talchir ironstone shales; concretionary masses in the Upper Barakas group; nodules of laterite. Large manufacture in olden times.

Chutia Nagpur.—Ores in Jashpur and Gangpur, perhaps lateritic: famed for weapons and tools.

Vizagapatam.—Brown hæmatite, as matrix of a breccia; lateritic ores. Wútz made at Madgole.

Sambalpur.—Bands of decomposed magnetite; ironstones of the Kingir sandstone series. Large manufactures of tools and weapons.

Bilaspur, Raipur, Mandla.—Former large mines and manufacture.

Jabalpur.—Kumbhi black iron sand; hæmatites from Gondwana sandstones; lateritic ores of Bifaragugarh; Jaoli ores from transition (Bijawar) rocks.

Narsinghpur.—Tendukhera ores in irregular pits in transition rocks; masses of specular iron; brown and red hæmatites. Steel made here until 1827.

Sagar, Damoh, and *Koshangabad.*—Very pure red hæmatite in nests, in transition bands of brown hæmatite, in metamorphic rocks.

Nimar.—Barwai ores, breccia in matrix of brown hæmatite; Nandia limonites in globular lumps; Mitanderpur rich hæmatites.

Surat.—Magnetic sand at the mouths of rivers; ores of Balsar, Pardi, and Bodhan. Old manufactories.

Koukan.—Rich laterites; also magnetic and hæmatitic ores associated with metamorphic rock. Old works at Vingorla, Malwan, Kapadvanj, Jambughora, Sunodra, Bhelod, Ratanpur, and Tadkesar.

Godavari Basin.

Bhandara.—Mines in Chandpur, Tirora, Pratabgarh.
Balaghat.—Old mines.
Chanda.—Khandeshwar Hill ores (near Dewalgaon); Lohara Hill Ores, compact crystalline hæmatite, with some magnetic oxide,—69 per cent iron; Pepalgaon ores, similar, and masses of brown hæmatite; Ratnapus brown iron ores, 50 per cent iron, in lodes; also ores at Ogulpet, Metapur, Bhanapur, Menda, Gunjwahi,—mostly hæmatite, but also magnetic ores; besides rich lateritic ores.
Haidarabad.—Dimdurti scaly iron diffused in gneiss; Mirtapalli magnetic iron sand; Kondapur lateritic iron; Hunumkonda magnetite; Warangal titaniferous iron ore, also hæmatites; Kullur and Anantagiri ores.
Godavari.—Golapilli, Tripatti, and Rajamahendri ores from sandstone.

Kistna Basin.

Satara.—Mahabaleshwar nodular hæmatite associated with laterite. Manufacture of wutz.
Kothapur.—Ores in Vishalgarh, Kunala, and Kolhapur,—some are lateritic.
Karmil.—Pure specular ore of the Ganigal range.
Ballari.—Manganiferous and other ores unknown.
Moisur.—Black iron sand of Madhugiri and Chinharaindurga; also ironstone ore,—wutz made largely. Chittaldrug limonites and hæmatites; magnetic sand of Kostagiri; ores of Heggaddevankot and Malvilli; Kodachadri magnetic ores; Kadur ores; Chikayakanhalli ores.

Penner Basin.

Siliceous hæmatites, ferruginous quartzites, and other ores, from the rocks of the Kadapah series: agricultural implements made. Nellur magnetites of Ongole and Gundbakamma in gneissic rocks.

South-Eastern Basins, &c.

Chinglipat.—Iron ores of some sort; also near Madras.
Arkat.—Titaniferous magnetic iron sand of Teragutty, Trinomolai, and Chinna Tripatti iron ores. ;

Salun.—Enormous development of magnetic ores, in the Godumullay, Tullamullay, Singipullay, Tirthamullay, and Kanjamullay Hills. These ores were used in the Porto Novo foundries.

Koimbatur.—Magnetic sand and other ore.

Nilgiris.—Specular ores, hæmatites, also magnetites, at Kotagisi and Jakatalla.

Bepur.—Lateritic ores.

Malabar.—Black magnetic sand and laterite.

Trichinopolli.—Ferruginous nodules from cretaceous rock.

Madura.—Lateritic conglomerate; some magnetic iron.

Travankur.—Magnetites in syenite and granite; also laterite.

IV. PHYSIOLOGY AND ITS OPPONENTS.*

(Concluded from page 656.)

THE manner in which Bestiarians—many of them are sportsmen—excuse themselves for denouncing physiological research whilst justifying hunting, angling, &c., is farcical in the extreme. Miss Cobbe writes: "But it is almost ludicrous to compare a fox-hunt (for example), with its free chance of escape and its almost instantaneous termination in the annihilation of the poor fox when captured, with the slow long-drawn agonies of an affectionate trustful dog, fastened down limb by limb and mangled on its torture trough." Concerning this outburst, Mr. Robertson justly remarks, "Here we have a sample of the vicious reasoning of anti-vivisectionists, and at the same time an exhibition of positive defect of imagination arising out of the moral bias. Note the fatuity of the phrase about 'free chances of escape,' and the assumption that the fox suffers nothing save in the moment of death. But worst of all is the clear implication that to find enjoyment in the terror of a hunted animal is venial beside the simple act of inflicting pain for an ulterior scientific end. Miss Cobbe, after admitting that field sports do not 'seem to harmonize with the highest type of cultivated and human feeling,' goes on to say that the men who follow them may at least plead the excuses of custom and partial ignorance. This when the very contention in dispute is that the reasoned and deliberate scientific action is right, while the following of custom and primitive instinct is barbarous."

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* Apologia or explanation of my last Article on Vivisection which appeared in a London Journal, September, 1, 1884. By a "WEAK WOMAN" who withholds her name.

The Ethics of Vivisection. By J. ROBERTSON. From "Our Corner." August 1, 1885.

With all this we can agree. But in the sentence quoted from Miss Cobbe falsehoods and fallacies lie strewn so thickly that Mr. Robertson does not note them all. The dog, when such happens to be the subject, is not necessarily "affectionate and trustful." He is not subject to "slow, long-drawn agonies," because he is, unlike the fox, under the influence of anæsthetics. Further, in a large number of cases the operations are instantaneous, and occasion about as much pain as does vaccination.

But Miss Cobbe, besides her exaggerations and distortions of facts, shows, in selecting "for example, a fox hunt," no small degree of petty cunning. Let us, on the contrary, take for example a tame deer which has no more "chased and been chased all its days" than has a calf, but which is, some fine day, brought in a cart to be hunted by the royal buckhounds. What of its terror? Or take the case of a salmon hooked, and "played," as we have read, for *three hours*. This play consists in compelling the fish to swim with open mouth against the stream, unable to breathe freely, until it is, in fact, killed by exhaustion and slow suffocation.

Does not such a salmon sustain—if sensitive, and the Anti-Vivisection Act recognises its sensitiveness—more "slow, long-drawn agonies" than Miss Cobbe's "affectionate, trustful dog?" Or, take the case of a frog, impaled alive on a hook and left all night struggling in the water as a bait for jack? Yet these anglers are absolved both by the Act and by the sentimentalists, whose shrieks have been the main argument in its favour. Or, again, let us consider pigeons or sparrows shot down at meetings of gun-clubs, but not necessarily killed; left to lie in pain until discovered by some prowling weasel, cat, or "affectionate trustful dog." Surely in these instances, and in many more which might be adduced, there is "torture" not instantaneous, but prolonged, not assuaged by anæsthetics, certainly equalling, or rather exceeding in amount, the average of the suffering inflicted in physiological experiments. What right, then, have those who practise such things themselves as a mere pastime, or who defend them when practised by others to turn round upon the physiologist who inflicts, in a few instances, pain in pursuit of knowledge? Of all the inconsistencies which have stained human nature, this, surely, is the most glaring.

Another argument of the Bestiarians, or what passes for argument with them and their dupes, is to call the physiologist "cold-blooded." He acts, of necessity, calmly and deliberately, and is therefore, forsooth, to be execrated, whilst the sportsman, the aggressive soldier, Muscovite or other, the cock-fighter, bull-baiter, and the like, is to be pardoned because he gets excited!

To this Mr. Robertson replies that, "thoughtlessness in sport, as in everything else, makes against civilization."

But we may go further; the fox-hunter is, doubtless, excited when the hounds are in full cry, and when he plies whip and spur, dashing onwards to be in at the death. But was the same sportsman excited when he carefully selected his hunter, when he bought and donned the orthodox costume, when he subscribed to the hounds, and when he rode to the meet? We trow not; we believe that in all these things he acted as deliberately—as "cold-bloodedly" if you prefer it—as does the experimental physiologist in carrying out his researches.

"In the field of battle, where every man in each contending army fights for home and country under the inspiration of enthusiasm, ambition, or the desire for renown," as that "facile sciolist," Dr. Anna Kingsford, exclaims, the individual soldier may get excited. But where is the excitement in an imperial *chancellerie* when the command, or the tacit permission, is given to attack some unoffending neighbour?

Here, surely, if anywhere, is "cold blood." Yet, if report belie him not, an eminent statesman has recently joined the Bestiarian ranks who, not very many years ago, quietly prepared for a struggle, and then deliberately, and of malice aforethought, tempted an unprepared neighbour to declare war.

"Blood," it seems, may be freely shed provided it is only not that of dogs, and "iron" may be used with the full sanction of Bestiarian oracles, if only it be in the shape of bayonet and sabre, and not of scalpel.

Mr. Robertson asks:—"Ought we to help to maintain close checks on vivisection whilst those who oppose the practice not only clamour for its entire suppression, but openly make light of barbarous practices, as to the immorality and perniciousness of which there can be no dispute among cool moralists?" He further declares that: "We have the spectacle of the anti-vivisection movement making for irrationality in ethics, empiricism in general thought, gross partiality in practice, falsehood in controversy, and the encouragement of the military spirit."

There is a further sneer against physiological research, common enough, but which does not come under Mr. Robertson's searching analysis. Physiology is dubbed the "coward science." Physiological expediency is "cowardly." Let us for a moment look closely into the pseudo argument. The term coward is rightly and logically applied to the man who shrinks from danger which it is his duty to encounter, and to him only. But an action cannot be rationally called cowardly because it happens to involve no danger. "Vivisection," moreover, is often exceedingly dangerous. Pasteur, a man who never took the life of any creature for amusement, has often been in extreme peril in his researches on rabies. When collecting the virus from the jaws of a mad dog the slipping of a cord, or the slightest inaccuracy of manipulation on his part would, without fail, have involved a fearful death. But the employers of this phrase seek to justify it by the cavil that it is "cowardly" to inflict pain or death upon beings which are unable to resist. It is hard to realise the full absurdity of this plea. The very essence of experiment in any science is that the substances acted upon shall have no power of withdrawing themselves from the intended reaction.

But if physiological experimentation is "cowardly" because the subjects cannot resist, ninety-nine-hundredths, at least, of the cases where man inflicts pain or death upon the lower animals fall in the same category. What resistance can the colt, the calf, or the pig make against the castrator? How is the sheep to defend itself against the butcher, or the chicken, turkey, or duck against the poulterer? Can the pheasant, the partridge, grouse, or snipe withstand the sportsman? Even the ox is so secured in the slaughter-house that escape or resistance is out of the question. Why, then, should the term "coward" be bestowed upon the physiologist rather than upon the butcher, the sportsman, the castrator, or the drover, or all who torture or destroy animals for convenience, for amusement, or for gain? Every conceivable answer which can be given to this question is a demonstrable falsehood, save one. And that one is that the maenads of Victoria Street are very willing to dispense with science—in fact, preferring ignorance—but are not for a moment prepared to dispense with mutton and veal, duck and turkey, oysters and lobsters, furs and feathers, or with "manly" sports and the compulsory services of beasts of burden. We plead merely for some approach to logical consistency, and we plead in vain. So far as we can see, one man, and one only, if such exist, is intellectually and morally free to take up his parable against "vivisection"—the man who holds it wrong to inflict pain or death upon the lower animals for any purpose, and who lives up to his profession. Such a person might legitimately institute a "zoophilist" crusade, and might, undoubtedly, if he thought proper, begin by attacking experimental physiology. In so doing he, at least, would not be open *ab initio* to the charges of inconsistency and hypocrisy. Whether he would avoid the mendacity which clings like Gehazi's leprosy to agitators is another question.

But we must now turn from Mr. Robertson and his most able exposure of the sophisms of Miss Cobbe to the production which we have bracketed along with his memoir. The anonymous authoress is so wild in her statements and her ideas that Miss Cobbe, Mrs. Kingsford, and her other colleagues seem, in comparison, calm, consistent, and rational. Her circular, or whatever it may be called, is said to be a reprint from a "London journal." Whether it be from the "Zoophilist," the "Police News," or the "Spectator" we do not care to inquire. But we must say that it consists of misstatements in fact blended with almost every possible variety of fallacy,—such an Augean stable of misconception and misrepresentation that no man knows where to begin its exposure. It is sad, pitiful in the extreme, that in a so-called civilized country even one person can be found to write as this anonymous lady has written—sadder and more pitiable still that in some quarters she evidently meets with sympathy. She begins by proposing that condemned criminals, instead of rabbits, guinea-pigs, dogs, &c., shall be made the subjects of physiological experiments. She asks why a doctor may not go to a condemned cell and say: "There is an operation to be performed in the hospital the day after to-morrow. It is useless to use animals for it *because their bodies are not in the least like ours* (*sic !*), and the results are not much, if any. If you like to accept the risk you may. It will be to my interest that you suffer as little as possible, and to the honour of my profession if you survive the operation. If you recover, you are granted a free pardon unless you repeat your crime of murder and brutal violence."

We must first call attention to the words which we have italicised, and which the authoress coolly puts into the mouth of a doctor.

We next point out that the esoteric object of this strange proposal is doubtless to bring physiological experimentation into contempt and hatred. Experimentation on human subjects would be useful only if the question were to decide as to the practicability of some newly-projected operation. In other cases they might be perfectly useless. The writer before us, like many of her colleagues, conceives of experimentation from a simple and directly medical or veterinary point of view. The experimentation on animals, for which we contend, has for its point of view pure research in general physiology. But, even with the narrower object of direct medical or surgical application, the proposed experimentation on criminals would break down. Let us consider the recent researches of Pasteur on rabies, which have been of late so signally verified.

He found that the poison of rabies, if introduced into an animal of a given species, and transferred from that specimen to another of the same species, becomes attenuated, whilst, if passed through a series of another kind, it retains its virulence. How could he have discovered this capital fact if his experiments had been confined to one only species—human subjects? Again, condemned criminals are few, and are not always to be had when wanted.

To take a very different question, it is desirable to ascertain the influence of different kinds of water—within the limits actually occurring in nature—upon fish. Do they thrive better or worse in hard or in soft water, in waters holding in solution salts of lime or magnesia, in slightly brackish waters, &c. Such investigations are needed from a double point of view, both as regards the multiplication of food-fishes and to ascertain the influence of such conditions upon the formation of varieties, and ultimately, perhaps, of new species. Now, if experiments are to be performed on man only, how could such and hundreds of other researches be performed? Perhaps it may be argued that such experiments are not "vivisection." Logically they certainly are not. Legally, *i.e.*, within the meaning of the disgraceful "Anti-vivisection Act," they probably are. At least, certain physiologists about to engage in such researches have been advised by counsel that it would be prudent to obtain (if they could) the usual license under the Act.

But the writer warms to her subject. "Personally speaking I believe animal vivisection to be worse than useless; it is misleading and wholly sinful—an abomination in the sight of God. I believe all the passions are sisters, and the lust of cruelty is one which in all ages has had its safety valve, always in a virtuous form, always protected by existing governments, the same as other things, whether it was throwing Christians to tigers in the arena after a Pagan feast, or the Holy Inquisition, or vivisection. Education and civilization have swept away all the other sorts except this last, and the day is not far distant when the world will be ashamed of this as of the others, and will look upon operators (whose names, addresses, and exploits are handed down to posterity in a directory published in Victoria Street, London) with the same eyes and feelings as if they were executioners or inquisitors, and their memory will be as those."

Surely a more foully and falsely libellous passage was never penned! It is a falsehood to say that experimentation upon animals is a "safety valve" for the "lust of cruelty."

The feelings of the experimentalist are just the same in the physiological as in the chemical laboratory. It is not his object to give pain, and in those cases where it might occur it is rendered impossible by anæsthetics. If a man take any delight in torture, he can indulge this feeling to the full without licenses, without anæsthetics, so long as his object is not scientific. So the "passions" are sisters? What, then, of the passion for "profligate lying" to which Mr. Robertson refers as a Bestiarian characteristic? Again physiological experiments are not "protected" by the British government: they are rendered all but impossible. Further, experimentation on animals—if it be cruel, which we deny—is not the only "sort" which has not been swept away. "Sport," in all its forms, exists practically unchallenged, and inflicts tenfold more pain upon animals than is done by "vivisection." As to the Victoria Street Directory, we know that the world will recover from its temporary fit of madness; the names enrolled in that directory will be honoured as those who upheld the cause of science amidst insult, obloquy, and positive persecution, whilst a wiser posterity will rank the Bestiarian advocates with Caccini and Scioppius, or with the monks who tore Hypatia to pieces, and who destroyed the Alexandrian library.

Vilification through every possible channel has been throughout a favourite weapon of the Bestiarians. We have received anonymous letters in abundance, rich in insults and threats, but never containing anything worth the name of argument.

But we will not drag our readers any further through this writer's outbreaks, vitiated as they are by the fundamental assumption that to inflict pain in pursuit of knowledge is "murder in the second degree," whilst under other circumstances it is lawful, or at least venial. Will the time ever come when the "emancipation" of vegetables will be as furiously advocated?

V. FROM THE DEBATEABLE LAND.

DEBATEABLE LAND? Between the physical and the psychical, possibly the metaphysical. We feel it our duty to notice certain experimental results obtained by eminent men, surrounded by sceptical witnesses, and employing all the precautions which science can suggest. Yet the phenomena obtained were of such a nature that unless some subtle source of error is detected we must await an important extension, and perhaps a rectification of our knowledge not merely in biology, but also in chemistry and physics. Let us venture to say that the new discoveries awaiting us seem likely to reinforce certain views still received by official savants with ridicule or with the conspiracy of silence.

Most of our readers will have heard of, perhaps witnessed, the experiments which some time ago were frequently exhibited under the absurd name of "electro-biology," which has since been modified in certain quarters into "biology." Without describing the well-known *modus operandi* in these performances, it will be sufficient to say that the subject was, for the time being, completely governed by the mind of the operator. If the latter handed him a lump of tallow, with the assurance that it was a piece of sugar, or a peach, the subject ate it with evident relish. We once witnessed an experiment where such a subject, an unwholesome-looking lad, was told that he was in a dark cellar. Although the room was brilliantly lighted, and though a candle was held close to his face, yet the pupils of his eyes remained widely expanded, like those of a person in utter darkness. We accepted this phenomenon as proof that the lad was not a confederate, as we had previously had the opportunity of observing that before he was thrown into this state the pupils of his eyes expanded and contracted in the ordinary manner according to the degree of light. It must be noted that this peculiar state, however it may be explained, soon passed away, the operator retaining no prolonged control over the subject.

Recently, however, this process of—shall we say hypnotising?—has undergone further developments at the hands of Dr. Charcot, of the Salpetriere, and results of a most curious character have been reached. The influence, or delusion, does not pass away in the course of a few minutes, but may continue after the subject has left the presence of the operator, and extend to the next day, possibly longer. A person who has been thrown into this state may be told to go the next day and shoot a person, some acquaintance, and then give himself up to justice. It is impressed upon him that he is to do this, not in obedience to the operator's command, but purely of his own motion, whether out of revenge for some imaginary insult or injury, or out of mere "superfluity of naughtiness." There can be no necessity for us to describe the experiments of this kind which have been performed, since accounts of them have been, and still are, "going the round of the papers." Still less need we enlarge on the possible moral results of such an ascendency acquired by one person over the mind of another. But a point at which we must briefly glance is their bearing upon the question of free will. A subject who has been thus impressed goes and commits some crime. He feels that he is doing this wickedness, not at the command of the operator, but of his own motion. Yet, in reality, he has not been in this action a free agent at all, but a mere puppet, a machine performing the will of another, and yet retaining the belief in his own freedom and responsibility! Who can help asking, What, then, becomes of the doctrine of free will altogether? Who does not further feel anxious to learn whether there may not be other conditions in addition to that of hypnotic trance in which human beings may be subjugated by a foreign will whilst retaining a firm belief in their free agency. Experience seems to tell us that such is the case. Witness the manner in which weak-minded and impressionable people—it must be remembered that Dr. Charcot's experiments succeeded only upon certain individuals—are not merely carried away for the time being at "mass meetings," revival meetings, &c., but are controlled in their subsequent conduct. This control they fancy is due to a rational conviction, whilst in most, if not all cases, it is an influence not depending upon reason but upon emotion. To give instances would be out of the question in an organ like the "Journal of Science," which has nothing to do with sects and parties.

Dr. Charcot's hypnotism differs from the primitive "electro-biology" in that the subject executes the commands or suggestions of the operator, not during trance, but in what he supposes to be a normal state. It agrees with hypnotism in the control of the operator over the subject, and in the circumstance that out of a number of persons experimented upon but few are found distinctly susceptible. Those most susceptible are generally more or less of a hysterical temperament.

This circumstance links the above-mentioned phenomena to a class of results obtained by Drs. Bourru and Burot, of the Naval Medical College of Rochefort, and recently described by them at the Grenoble meeting of the French Association for the Advancement of Science. They have found that, upon hysterical subjects at least, various medicines act not only without being swallowed, but even without being touched. We are thus reminded of some of the most ridiculed results of the late Baron Reichenbach. One of the subjects of these experiments was a young man, of feeble constitution, admitted at the Rochefort Hospital on March 27th, and who has since been attacked with a series of hystero-epileptic crises, upon which he became paralysed and insensible on the whole right side of the body.

In presence of this paralysis, the hysterical character of which was not doubtful, the first care of the observers was to try the action of metals. Zinc, copper, platinum, and iron were distinctly active, though in unequal degrees. The effects of gold were particularly striking. Not only did any article of gold, on contact with the skin, produce an intolerable burning, but even at a distance of 10 or 15 centimetres the burning was felt, *through the clothing and through the closed hand of the operator.* The mercury in the bulb of a thermometer, if brought near his skin, but without contact, occasioned burnings, convulsions, and attracted the nearest limb. Chloride of gold, in a stoppered bottle, if brought within a few centimetres of the man's body, produced effects very like those of metallic gold. On bringing near the subject a crystal of potassium iodide, there resulted yawning and repeated sneezing. There was thus the well-known physiological action of this salt in irritating the mucous membrane of the nose. The observers were still more surprised to find that opium made the patient sleep by its mere proximity.

These facts were so strange that the observers did not at first feel free to make them known, scarcely believing the evidence of their senses. The experiments were repeated in presence of various colleagues, who were admitted not merely to observe, but to devise the most varied and difficult counter-tests.

After some months of observation and of prudent reserve MM. Bourru and Burot met with a second hystero-epileptic subject, who gave the same reactions as the former. This patient was a woman, aged 26, insensible over the whole right side of the body, but excessively sensitive on the left. The results with the two subjects were essentially identical.

The observers requested Dr. Duplouy, Director of the Naval Medical College of Rochefort, to be present at a check-experiment. This gentleman, being absolutely incredulous, demanded the most rigorous conditions. All persons who could influence the subject had to be removed, and an absolute silence was maintained. The experiment was made in the presence of the director, the professors, and assistants of the College, and a great number of naval surgeons and pharmacists. The scientific authority of this assembly was of the greatest importance. The experiments were decisive, conclusive. A bottle containing jaborandi, brought by an assistant, was placed near the patient by another person, and immediately occasioned salivation and sweating. An experimentalist, having in his pocket two bottles of the same size, both wrapped in paper, and wishing to put the patient under the influence of cantharides, found him behave as if affected by valerian. The experimentalist was surprised, but every one saw, on removing the wrapper, that instead of presenting the bottle of cantharides, as he had intended, he had presented the other, which in fact contained valerian. All the spectators were satisfied, and Dr. Duplouy declared openly that he was convinced in spite of himself.

Afterwards one of the two subjects was transferred to the asylum of Lafond, at La Rochelle. Here Dr. Mahlle repeated all the experiments, and vouched for the accuracy of the results in communications to the Society of Medicine and the Society of Natural Sciences at La Rochelle.

Into the methods of experimentation which these physicians finally adopted we cannot enter; nor can we give the details of the action of the different drugs tried.

Alcohol from different sources occasioned very distinct effects. The alcohol of wine in different forms always induced a gay drunkenness. Alcohol from grain, on the contrary, occasioned a furious intoxication, and a true scene of rage. Absinthe produced paralysis of the legs.

Cherry-laurel water occasioned in the female subject phenomena so surprising that they were repeatedly studied and scrutinised in detail. There was at first a religious ecstasy, which set in almost instantly, and which lasted more than a quarter of an hour. Some seconds after the application of the substance her eyes were turned upwards, her arms rose up slowly, her hands were extended towards heaven, her figure seemed to respire beatitude. She fell on her knees, with her head bowed down in the attitude of prayer. Soon she prostrated herself in adoration; she wept, with her head touching the earth. Convulsive movements of the thoracic muscles and the diaphragm follow, succeeded by a calm sleep.

When the subject was again under the influence of this hallucination she was somnambulised, and asked what she had just seen? She replied that she had seen the Virgin Mary, clad in a blue robe with stars of gold. The Virgin had reproached her for her disorderly life, told her to pray for a change of conduct, and finally gave her benediction. When awake the woman, who is a Jewess, scoffed at all mention of the Virgin. This experiment was repeated many times, always with the same result. On scrutiny it was found that the laurel-water contained both prussic acid and the volatile oil of laurel. The prussic acid, used alone, determined thoracic convulsions without visions; the volatile oil brought on the vision alone without convulsions.

Nitro-benzol was next tried: it occasioned convulsive shocks in the entire body. There was then observed a rhythmic trembling in the right arm, which was uplifted as if the patient was executing a drawing. She said afterwards that she had been sketching.

In the male subject laurel-water did not occasion ecstasy, but immediate thoracic convulsions, hiccup, and salivation. The volatile oil of laurel occasioned excitement without ecstasy. Nitro-benzol brought on convulsions of the arms, and the same hallucination of sketching or drawing.

Valerian, generally considered as a sedative, occasioned in both subjects a violent excitement, with odd phenomena analogous to those which it produces in cats.

In all these phenomena the authors distinguish psychical actions, consisting in a variety of hallucinations probably specific to each subject, and physical actions, the chief of which are salivation, vomiting, intestinal contractions, sneezing, yawning, sleep, sweat, affections of sight, and alcoholic stumbling.

Observations have also been made upon a number of patients less sensitive, and the results obtained, though less decided, were confirmatory.

A hysterical patient has been thrown to sleep by placing in her hands a bottle of chloral hydrate. A hystero-epileptic patient, in the care of M. Dumontpallier, was sent to sleep by the approximation of opium. In M. Charcot's ward a woman submitted to the contact of alcohol displayed obstinate drowsiness, tottering, heaviness of the head, a moderate pleasant drunkenness, and then vomiting,—symptoms which were removed by ammonia.

Another hystero-epileptic woman was instantly affected by alcohol, feeling heaviness in the head, intense stumbling, and repeated efforts to vomit. A patient in Dr. Brouardel's ward was affected by alcohol chiefly in the legs, and could not remain on her feet.

Though such decided effects were produced only in a small number of cases, we may believe that an influence, however slight, may be occasioned in most hysterical subjects.

The authors by no means profess to explain these "almost supernatural" facts. They consider that three theories may be put forward: (1) the theory of suggestion; (2) that of vibration: and (3) that of radiating nervous force, or, rather, of a nervous field.

The first theory is incapable of accounting for the facts, especially for that case where a person presented to the patient valerian, believing that it was cantharides. The results, however, were not those of cantharides, but of valerian.

The theory of vibrations, already put forward by M. Vigouroux to explain the action of the magnet, might be also discussed and appropriated to these facts, but it appears quite insufficient. M. Vigouroux himself avows that this idea of vibrations offers us a means of comparison and of schematic representation, but not explanation. He adds that in the present state of Science it is no explanation to say that a phenomenon is of a vibratory nature, for everything is vibratory.

Finally, there remains a third theory, that of radiating nerve-force, developed by M. Baréty, at Nice, in 1881. The idea of the exterioration of the nerve-fluid to a distance presents powerful analogies with certain well-known physical facts. A globe of hot water radiates heat; a magnet has its magnetic field. The force accumulated in these apparatus radiates outward, and bodies which are found within a given radius undergo its action. It is true that, if a nervous force is suspected, its existence is by no means demonstrated. But it is as impossible for the physicist to prove directly the existence of the ether as it is for the physiologist to prove in a direct manner the human [better, animal] nervous field. We suspect the existence of the ether from its effects; we admit magnetic forces at a distance without seeing them, by observing that iron placed at a certain distance is attracted. In the same manner, if it be proved that a substance acts upon the human body at a distance, there must exist a something which is impressionable. This impressionable *zone* will be manifest only in those conditions of development of nerve-force which are peculiar to hysterical subjects. In these conditions the phenomena of medicines acting at a distance is easily explained: they are at once plunged into a nervous *zone* which they impress by determining special physiological actions, mostly of the nervous order.

The discovery of MM. Bourru and M. Burot is full of consequences in the sphere of physiology and psychology, and it is impossible to foresee to what it may lead.

VI. ON THE IRRECIPROCAL CONDUCTION IN THE ELECTRIC ORGAN OF THE TORPEDO.

DURING the years 1883, 1884 and 1885, Prof. Du Bois Reymond has had repeated opportunities of examining living specimens of this singular fish, and has communicated his results in the "Transactions of the Berlin Academy of Sciences" ("Sitzungsberichte der Berliner Academie der Wissenschaften," 1885, p. 691) and the "Naturforscher." Notwithstanding the much enfeebled and consequently inefficient state of the fish, he succeeded, by means of skilfully arranged investigations, in establishing a series of facts which are a very important contribution to the full understanding of these mysterious electrical organs. We shall, for the present, consider only one of his results —the irreciprocity of the conduction in the electrical organ.

On examining the phenomena of polarisation presented by the electric organ when traversed in rapid succession by currents of brief duration passing alternately in the same direction as the animal's own current, from the belly to the back (or, as Professor Du Bois Reymond calls them, homodromous currents,) and in the opposite direction (heterodromous currents, the preponderance of the former (homodromous) was found most decisive. The thought immediately suggested, of an unequal conductivity of the electric organ for currents of the same and of an opposite direction, seemed to require a definite experimental investigation. In the first place it was necessary to decide whether the stronger action of the homodromous current as observed was merely apparent, or really existing.

The first observation made on the more precise observation of this phenomenon was its very striking dependence on the density of the current. If the opening shocks of a sledge-induction-apparatus (the primary coil being filled with rods of iron) were passed through the preparation from one skin-surface to the other, alternately in a homodromous and a heterodromous direction, the deviations of a galvanometer placed in the same circuit were greater with homodromous than with heterodromous currents. The ratio of the heterodromous to the homodromous deflections was = 100 : 224·7, if the distance of the secondary from the primary coil was 0; if this distance was 10 centimetres the ratio was = 100 : 105·1, whilst at a distance of 15 centimetres the ratio became 100 : 100. From the experiments, of which the figures quoted form merely a specimen, it follows firstly that the phenomenon becomes perceptible only when the strength of the current passes a certain limit, and secondly that the irreciprocity increases with the strength of the current, though more slowly than the density.

It was further established by experiment that the difference in the strength of the currents becomes visible not only when they are passed from one polar surface of the preparations (covered with skin) to the other, but between any given points of the lateral surfaces of the preparations, the more strongly the more remote from each other the points are situate.

If induction currents were passed to the lateral surfaces of the preparations by means of unpolarisable electrodes, the heterodromous deflections in a long layer of the organ were to the homodromous as 100 : 39·1; in one of medium length as 100 : 45·8; and in a short distance only as 100 : 78·4.

The irreciprocity was therefore the greater the longer the part of the electric organ traversed.

But, decisively as the experiments here referred to seem to support the irreciprocity of the conduction, Prof. Du Bois Reymond considered it as not yet demonstrated. The phenomena might possibly, though very improbably, depend on polarisation. But, without reference to the interpretation, it was important to effect a direct measurement of the conduction of the electric organ, and to compare it with that of other tissues.

According to a method which Professor Du Bois Reymond had formerly used for determining the resistance of the muscles of frogs, he compared with each other the conductive power of a solution of common salt at $\frac{3}{4}$ per cent; of sea water, of the muscular flesh of a frog, and of the organ when traversed by a homodromous or heterodromous current. All these were, in succession, placed in one and the same tube, and introduced into the same circuit. It appeared that the electric organ of the torpedo, in a homodromous direction, conducts twice as badly as frog muscle parallel to the fibres, and from 7·5 to 12 times worse than the sea water of the aquarium. In the heterodromous direction the organ conducted 20 to 58 times worse than sea water. Experiments were made on the conductivity of the organ in a transverse direction, induction shocks being transmitted sometimes from the belly to the back, sometimes from the back to the belly, and sometimes transversely from one lateral margin to the other, *e.g.*, in the homodromous direction 80·7, in the heterodromous 22·5, and transversely 99 degrees of deflection. When the lateral margins were covered with skin in order to equalise the conditions as far as possible, there was obtained a deflection in the transverse direction of 95 degrees of the scale either with or without skin, in the homodromous direction without skin 75 degrees, and in the heterodromous condition, likewise without skin, 18.

The low conductivity of the organ, and its irreciprocity, depend, as further experiments showed, on life. If the tube, filled with the columns of the organ, was plunged for a few minutes into boiling water, the conductivity of the organ was increased. Its resistance in both directions was now equal, and was smaller than the smallest resistance in the homodromous direction, smaller even than that of the physiological saline solution. The same increase of conductivity, and the simultaneous decrease of irreciprocity, occurred on the spontaneous death of the organ, so, after decomposition had set in, the conduction in both directions was equal.

From these facts Professor Du Bois Reymond infers that the existence of irreciprocal conduction in the electrical organ may be regarded as established. But, as all the experiments showing the irreciprocity of the conduction had been performed only with induction shocks, or with battery currents of brief duration, experiments were now made with the currents of a Grove's battery, and the circuit was kept closed so long as was possible without a too great disturbance by heating, polarisation, &c. The result was that with a prolonged closing of the circuit no irreciprocity of conduction appeared, though during a momentary closing it was very strong and even; if the circuit was kept closed for a second it was decidedly weaker. There can be therefore no doubt that the irreciprocal conduction of the organ depends both on the density of the current and on its duration. The homodromous resistance is independent of the density and the duration of the current, whilst the heterodromous resistance with currents of low density does not greatly differ from the homodromous. But when the density has reached a given limit value the heterodromous resistance becomes greater the greater the density and the briefer the duration of the current. Probably as the density of the current increases it reaches an upper limit, and with the increasing duration of the current a lower.

As to the cause of the phenomenon, it is for the present impossible to form a satisfactory conception. It seems as if the heterodromous current, as soon as its density in the preparation exceeds a certain value, the "limit-value," encounters a peculiar resistance, to overcome which a certain time is required. This supposition would explain why, in the case of brief currents, the irreciprocity of the current is strongly manifested, whilst little of it appears in case of prolonged currents.

But, though the irreciprocal conduction of the electric organ has not as yet been traced to its cause, it is very interesting to note that this phenomenon plays a not unimportant part in the economy of the stroke of the torpedo.

If we conceive a single column of this electric organ as surrounded by an infinite, conductive mass, we may design the curves of the current with which the space is filled by this current. They pass symmetrically to the axis and to the transverse median plane. Current nerves issue not only from the positive hinder surface of the column, but also from the lateral surfaces above the median plane, returning below it to the lateral surfaces, whilst those issuing from the back-surface return to the belly-surface. Within the columns there is a current from the belly to the back. If we now suppose that in the conductive mass there are, besides the first column, other similar columns with parallel axes, the lines of the current in any given surface-element of the external space are compounded according to the parallelopipedon of forces. But, as each column represents for all the others a portion of the external space, each is traversed in a heterodromous direction by a portion of the current-lines of all the others.

For any given part of the external space the other columns form, for the lines of current impinging upon them, a by-circuit. The worse this conducts the stronger are the currents passing through the portion of space in question. If we imagine all the other columns insulating, the action of the one column upon the part of the external space in question will be strengthened.

[It will be well to bear in mind that the word "column" as here employed signifies a galvanic combination, and is used as being less misleading than "battery."]

The electric organ is not, indeed, an insulator, but it possesses, as the above-mentioned investigations show, the power of irreciprocal conduction. The current-lines are all, where they impinge upon the organ, heterodromous. Consequently they encounter in the organ a resistance which has practically the same effect as if the organ were a non-conductor. In virtue of irreciprocal conduction there occurs the remarkable phenomenon that each column conducts its own homodromous current relatively well, but blocks the way for the heterodromous current-lines of all other columns. As this applies to all the columns, the current-lines of all are compelled to take the circuitous route round the edges of the electric organ. The total current in the external space consequently increases in density or in physiological action.

The concluding observations of Professor Du Bois Reymond are here given verbatim :—

"I formerly succeeded, when examining the electrical fishes, in detecting surprising instances of that organic purposiveness which fills anew even the strict adherent of mechanical causality with astonishment. I showed how the form of the electric organs of the torpedo on the one hand, and of *Gymnotus electricus* and *Malapterurus electricus* on the other, is adapted to the different conductive power of sea-water and fresh water ; how, during the growth of the gymnatus and the torpedo the electric organs are developed in the very directions which fresh water and salt water respectively require ; how the electro-motive forces of both these fishes are found, on measurement, to be approximately what the resistances of fresh water and of salt water require ; how the positive polarisibility of the organ is adapted to increase the stroke by rapidly succeeding shocks, whilst the negative effects by tetanisation, the object that a new discharge begins again almost from null. I proved the necessary immunity against electric shocks possessed by these fishes and their spawn. Lastly, the remarkable nerve tufts discovered by Wagner in the organ of the torpedo seemed possibly to have the power of causing all the electric plates innervated by the same primitive nerve fibre to come simultaneously into action. In one point only we failed to understand the arrangement of the electric organs of the torpedo : the part of the external space above the back of the fish, bordering on the sagittal plane, though most in need of protection, seemed to us, in the language of military engineers, a "dead angle." This evil is, to a certain extent, undoubtedly obviated by irreciprocal conduction."

"However this may be, the instance of internal purposiveness which we have found surpasses in ingenuity, so to speak, all the former. It would certainly have required the most profound meditation of a gifted thinker to suggest the idea of making each column a good conductor for its own current as far as the general properties of animal tissues permit, but comparatively a non-conductor for the current of all other columns. Not the least clever point is that since the shock of the electric fishes is quickly transient the organ conducts irreciprocally only brief currents. These would have no use in rendering it a perfect non-conductor for permanent heterodromous currents.

The distribution of electric force in the organic world is a mystery. We have an electric plant, an electric bug, an electric slug, and three electric fishes. Why this power should not occur in other forms of life is not understood.

VII. ACCLIMATISATION FROM ANOTHER SIDE.

SOME months back a paper on "Acclimatisation" was laid before our readers.* In it the author contended that the introduction of an alien plant or animal into any country was, from the point of view of organic geography, a mistake, as rendering it sometimes difficult to ascertain its indigenous flora and fauna. Economically considered, it is still more objectionable if the introduced species are weeds, granivorous birds, or mammals capable of maintaining themselves in a feral or semi-feral state, not to speak of death-snakes or beasts of prey. This subject derives an additional importance if we remember that there is in England no distinct law against importing and turning loose rattle-snakes, wolves, jaguars, &c.

But the introduction of useful and beautiful plants stands on a quite different footing, and, if scientifically carried out, may not merely prove a public benefit, but may throw light upon the part taken by natural selection in the origin of species.

But, unfortunately, the introduction of new plants has been hitherto attempted in a manner anything but scientific. At present plants from regions not differing too widely in temperature from that of England are introduced, and attempts are made, after a fashion, to accustom them to our climate. They are set in places sheltered from northerly and easterly winds, and freely open to the sun; and they are protected by means of matting and other devices in cases of severe frost. Or otherwise they are raised in a cool greenhouse, moved into the open air in the summer, and left out year by year, as they grow stronger for a greater length of time.

But there seems to have been no systematic attempt to conduct the acclimatising process on the principle of selection. Our florists and nurserymen apply this principle most thoroughly in their attempts to produce new flowers or new fruit trees. When a bed of young plants has come into bloom, or a plot of young trees, be they pears, plums, or what not, has fruited for the first time, they are "rogued."

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* Journal of Science, 1885, p. 205.

That is, all those which yield an inferior flower or fruit are pulled and thrown on to the rubbish heap, the superior varieties only being preserved. Perhaps one in a hundred is thus permitted to survive and is used for propagation.

But the same horticultural authorities do not seem sufficiently alive to the fact that among a large number of seedlings some may be superior to the generality in their power of resisting low temperatures. We learn from Mr. Jenner Weir, F.E.S., a most observant naturalist, that a great number of begonias, which the grower had intended to house for the winter, were overtaken by one of the morning frosts which have occurred so unseasonably in the present autumn. All the begonias, save one, were cut off. It becomes now exceedingly probable that if young plants were propagated from this resistant individual some one or more of them would be found still hardier than the parent, and thus, by a process of selection, we might, in the course of successive generations, arrive at a strain of begonias, and in like manner of other greenhouse plants, which should flourish in the open ground.

By a similar process of selection we might seek to produce fruit trees, which should come into blossom later than the ordinary strains, and thus escape the destructive action of spring-frosts. It would, of course, be needful to aim at the production of strains which mature their fruits in the shortest time. Of course the essential question, only to be determined by experience, is whether the power of bearing low temperatures, of blossoming late and yet ripening fruit early, can be obtained without a sacrifice, greater or less, of the valuable properties of the various fruits. But in so untrustworthy a climate as ours, where a temperature of 24° F. may be experienced as late as May 8th, the development of such strains or varieties should be aimed at if our soil is to yield its cultivators due remuneration.

VIII. THE CAUSE AND THE PURPOSE OF THE LUMINOSITY OF MARINE ANIMALS.

IN the opening address delivered by Prof. H. C. McIntosh before the Biological Section of the British Association the phosphorescence of marine animals was discussed at some length. The author gave an enumeration of the various groups of animals possessing this power, and described the manifold phenomena manifested. In conclusion he took into consideration the cause and the purpose of this phenomenon.

As he remarked, in the Protozoa the structure of the minute, and often very numerous, creatures which evince phosphorescence shows plainly that the presence of a definite nervous system is not necessary for its manifestation. The protoplasm of their body is itself sufficient for its production. Here there are no glands for the secretion of luminous substances, and in many there is evidently no fat which might undergo slow combustion. In the Cœlenterata the phenomenon seems to stand in close relation to nervous processes, though in certain cases the luminous substance possesses quite peculiar properties. Whilst in certain Annelida, such as *Chatopterus* and *Polycrrus*, there exist glands which may effect the secretion of a luminous substance in certain Polynoides, the emission of light seems to be due to a peculiarity of the nervous system. The irritability in the phosphorescent species of the latter family fluctuates greatly, some—*e.g.*, *Polynoë scolopendrina*—being sluggish, and others, on the contrary,—like *Harmothoë*,—exceedingly sensitive. In the Crustacea the luminous property seems to possess the character of a secretion, which is probably under the control of the nervous system. In *Pyrosoma* and *Pholas dactylus* a luminous secretion is a prominent attribute; and in the latter, as in the Annelida, death occasions its manifestation, which, to a limited extent, holds good in fishes also.

It is hence plain that the cause of phosphorescence is complex. In one group of animals it is derived from the formation of a substance which can remain behind like a luminous trail. The ease with which, in *Pennatula* and and other Cœlenterata, phosphorescence can be repeatedly elicited by rubbing the surface, which contains a minute trace of the luminous matter, points decidedly to other causes as co-operating. This function is plainly referrible to the organic chemical affinities of the tissues concerned. On the other hand, in certain Annelida it is a purely nervous activity, probably of kin to that which produces heat.

With the exception of Macartney, former authors have generally sought to connect the emission of light with the peculiar conditions of the depths of the sea. It was assumed that total darkness prevailed at the depth of 1000 feet, and that the phosphorescence of marine animals was for them a substitute for the light of the sun. It was further supposed that these lights were a guide to animals in seeking and attacking their prey, whilst, on the other hand, the power of withdrawing their light enabled them to escape dangers. It is well known that fish prey by night, and it was assumed that they were guided by the phosphorescence of their booty, since the light is particularly strong in those low animal forms which, by reason of their astonishing reproductive powers and of their dull sensibility,—little exceeding that of plants,—seem to be especially created for the nutriment of the higher forms. But with such theories great caution is necessary.

In the first place, the phosphorescent animals do not seem to be more numerous in the depths of the ocean than between high and low water-mark, or on the surface. On the contrary, the surface probably displays the greatest development of luminous species. Very many young animals which are said to phosphoresce strongly become surface-forms soon after leaving the egg, and people thus in their different stages all three regions,—the surface, the mean depths, and the abysses.

An examination of the life-histories of several phosphorescent groups does not supply any useful data for establishing a theory of the function of phosphorescence, especially with reference to nutrition. No phosphorescent form is more generally devoured by fishes and other animals than those which are non-phosphorescent. On the other hand, forms endowed with luminosity, if otherwise eatable, do not seem to escape capture. An examination of the stomachs of fishes proves this clearly, except perhaps the herring, which is pre-eminently a surface-fish. It is also not proven that such animals are always luminous, for many display a light only on irritation.

The irregularity of the appearance of phosphorescence in animals which agree in every respect in structure and habits further supports the view just put forward. Thus from the time of Pliny it has been known that *Pholas dactylus* is luminous, whilst the common *P. crispata* does not possess this property. Two Annelida, *Harmothoë imbricata* and *Polynoë flaccosa*, are both very common between high and low water-mark: they closely resemble each other in their habits and in their appearance, but the one is brightly luminous, while the other has not a trace of this property. Instead of enticing other animals as their prey, or of being themselves more readily captured, the phosphorescent Annelida are often inhabitants of tubes or guests of star-fishes. In fact, in the various groups, we find every variety of vital conditions combined with the presence of phosphorescence, so that the greatest care must be taken in drawing conclusions if they are to be of general applicability.

ANALYSES OF BOOKS.

The Wanderings of Plants and Animals from their First Home. By VICTOR HEHN. Edited by JAMES STEVEN STALLYBRASS. London: Swan Sonnenschein and Co.

THE title of this work raises expectations which the very first sentence of the Preface scatters to the winds. We hoped for a body of research showing how animal and vegetable species spread out from the point of their first appearance to the regions which now they occupy,—in short, for a work which should be the complement of Mr. A. R. Wallace's "Geographical Distribution of Animals." Such a task the author and the editor do not for a moment think of undertaking, and we trust they will pardon us for remarking they have not the necessary qualifications. We are told by the editor that "the history of our Domestic Animals and Cultivated Plants is a subject of absorbing interest to the educated man," and this history, accordingly, would seem to be the subject-matter of the book. But we find not a few of the most important cultivated plants omitted. We need merely mention as instances the tea-, coffee-, and cacao-trees, the various species of Cinchonas, the clove and the nutmeg and the vanilla plant, the yam and the banana. All these are important agriculturally and commercially, and all have spread over wide regions of the earth. Yet, from whatever reason, they are here overlooked.

On the other hand, we find mention of animals which are not domestic, and which follow man's footsteps much in the same manner as do epidemics. As instances we may take the mouse and the rat. But why, if these mischievous rodents are introduced, does the author keep silence on the wanderings of the bed-bug and the cockroach, which have now established themselves in all civilised countries; of the Termites, one species of which at least has become naturalised in South-western France; or of the house-flies and blood-sucking gnats, which, as Baron Osten-Sacken shows, have within comparatively recent times spread into regions where they were formerly unknown. In short, it is not easy to give the author's point of view in a few words. We may come nearest to the mark by saying that Herr Hehn confines his attention essentially to animals and plants which have been introduced by human agency into Europe.

We turn now to the author's method. He, or perhaps Mr. Stallybrass, expresses the opinion that questions as to the origin of animals are "susceptible of two or three different methods of investigation, which sometimes clash, and lead to opposite conclusions. . . . Our answers to these questions will be different, accordingly as we lean chiefly on Natural Science, or on Ancient History, Literature, or even Language. *The purely scientific man will judge chiefly by the suitability of soil and climate.* If he finds a plant flourishing pretty abundantly in Greece or Italy now, and knows of no climatic or geologic changes that would exclude the idea of its having flourished there 5000 years ago, he will at once pronounce it indigenous, and scout the notion of its having been imported."

This passage, and especially the words which we have italicised, is a complete misconception. The "purely scientific man" does not "judge chiefly by the suitability of soil and climate." He knows, as one of the most elementary truths in organic geography, that soil and climate form merely the exclusive limit to the existence of any given animal or plant; *i.e.*, if they are unsuitable such animal or plant will be certain not to exist, but it does not necessarily flourish where both are suitable. If he were to find, *e.g.*, a humming-bird in New Guinea, a bird of paradise in Venezuela or Trinidad, a squirrel or a deer in Australia, or a kangaroo at the Cape, he would at once pronounce it imported. The scientific method of deciding whether a species is indigenous or alien in any country is not so simple as Messrs. Hehn and Stallybrass seem to imagine. We examine, first, whether such species stands alone, or is found along with other species of the same genus, or of other nearly allied genera. In the latter case the probability of its being a rightful native is very strong. We next consider whether there are in the country concerned other animals, not near of kin to it, but capable of replacing it in the economy of Nature. Thus the occurrence of carnivorous Marsupialian forms in Tasmania, such as *Thylacinus* and *Dasyurus*, renders the indigenous existence there of placental Carnivora less probable. In like manner the rich development of antelopes in the Ethiopian region confirms the non-existence there of true deer. Hence if we found an apparently feral deer at the Cape we should feel all the more disposed to view it as imported.

Another consideration is the existence or non-existence of the species in question, in some region connected with the country under examination, by lands through which migration could have taken place. Thus, should a bear be captured in the Ethiopian region, we should hold it as having been imported, because the regions inhabited by bears are severed from Central and South Africa either by the ocean or by wide deserts.

The last main method of ascertaining whether an animal is indigenous in any country or not is the palæontological. If we find its remains in numbers in bone-caves, peat-beds, kitchen-middings, &c., and if, on penetrating into older strata, come upon traces of allied forms, we feel free to pronounce it indigenous.

The author and the editor of the work before us seem in great measure to repudiate these biological and geological methods. They think that "of late years the scientist has had too much his own way, that it is time for the historic and philologic methods to come into play and have their say."

We do not feel justified in a total repudiation of these methods. In doubtful cases they may turn the balance. Where more tangible evidence is wanting they may be precious. But we fear that, generally speaking, they are more apt to lead to ingenious speculation than to definite truth. The writer holds that if a plant is never mentioned by Homer, whilst later writers speak of it in a vague way, we may infer that the plant had been imported into Greece within historical times. To us this seems an unsafe inference. There is no necessity that every plant known, or even common in Greece, should be mentioned by Homer. If it is noticed more and more clearly by succeeding writers, this is likely to be due to the fact that, as agriculture, horticulture, and especially medicine, were more carefully studied, the flora of Greece, as of other countries, would certainly become more accurately known. Had early Greece possessed a work on *Materia Medica*, revised editions of which appeared every century, we should then have firm ground beneath our feet. But to estimate the fauna or flora of a country from mere literary productions, where the mention of plants and animals is merely casual, is certainly a rash procedure. What a grotesque notion should we form of the flora of England if we were to compile it from the writings of our poets, playwrights, and novelists!

As regards the natural history of the Mediterranean lands, we have often regretted that the botanical and zoological treatises of Solomon, mentioned in I. Kings, iv., 33, are not extant. In all probability they would have thrown an invaluable light on the origin and migrations of our domestic animals and cultivated plants.

Another difficulty besetting the literary and traditional method upon which our authors rely is the lack in olden times of a fixed nomenclature for natural objects. Hence the identification of animals and plants mentioned in the Greek and even the Latin classics, and in the Old Testament has been attended with no little unprofitable inkshed.

Another point must not be forgotten: when a people migrate into new abodes they frequently give to the plants and the animals of that region—perhaps nameless before—the names of the plants and animals with which they were familiar in their original seats. Of this we have abundant instances on the part of European settlers in America. In view of this trait of human nature the value of the philological evidence is greatly lessened.

To the naturalist the work before us must be pronounced of but small value, in virtue alike of its narrow scope and of its questionable methods. For the historian of culture, the ethnologist, and the philologian it will prove a treasure. In connection with these subjects we find not only wide and profound learning, but original and suggestive thought.

It may be strange, in a work bearing the title of that before us, to find an analysis of the causes which led to the overthrow of the Roman Empire. Thus Prof. Hehn writes:—"Another slowly operating destructive force, identical at bottom with that of Christianity, was the mixture of races, the intrusion of Oriental blood into the population of the West. . . . The rapid fall was only a consequence of the transformation of race. Natives of Africa and Egypt, Orientals of every type, European and Asiatic Greeks, Spanish Iberians, Illyrians, and Thracians deluged Italy, intermarried with each other, took possession of the organs of the State, of education, of literature, and not seldom even mounted the Imperial throne. As early as the time of Cicero and Cæsar all the cities, and Rome among them, were crowded with the circumcised, who were agreed among themselves; and however senseless and anti-human their opinions seemed to the Romans, yet with their stubborn bent of mind they imperceptibly revolutionised the general consciousness. 'Oh that Judea had never been subdued by Pompey and Titus!' exclaimed Rutilius Numatianus in his 'Itinerarium.' Thence comes, and now spreads far and wide, the infected matter, and those who were once conquered fasten the yoke on the necks of their conquerors!"

We may, perhaps, find here a trace of that Anti-Jewish movement which has of late made itself so conspicuous in Germany and the more eastern parts of Europe. However this may be, there is here matter which deserves to be heedfully studied by Cosmopolitans, Internationalists, and the advocates of "Miscegenation." It would almost seem as if, even without intermarriage, the intellectual and moral life of a people may be poisoned by the mere presence of aliens. Are we, in modern England, undergoing a similar progress?

We can recommend this work, not indeed to the naturalist, but, in return, to almost every one else.

Transactions and Proceedings of the Royal Society of Victoria. Vol. XXI., June 30, 1885. Melbourne: Mason, Frith, and McCutcheon. London: Williams and Norgate.

From the Anniversary Address of the President, Mr. R. L. Ellery, F.R.S., F.R.A.S., the Government Astronomer, we learn some satisfactory facts. The progress of botanical research is satisfactory. Baron von Müller has completed the tenth and last decade of his "Eucalyptography of Australia," and is issuing a Monograph of the Myoporinæ. He is also engaged on a work of higher scientific importance, on the regional distribution of the 14,000 Australian plants.

The Natural History Museum, under the management of Prof. M'Cay, has received several very important additions, especially some collections illustrative of the Zoology of New Guinea, and a fine collection from Borneo.

The Field Naturalists' Club is prosperous, and numbers nearly 200 members. Let us hope that they will work energetically at the almost endless questions which are sure to crop up in a country so sparingly explored as Australia.

Earthquake tremors have been of late experienced in Tasmania, and in the extreme south-east of the Australian mainland. Most of the tremors and rumblings, whilst startlingly manifest on the surface, were not noticed 12 feet or more below it, except sometimes in the open-timbered shafts of the mines. Even in deep cuttings they were often not noticeable." This would seem to indicate that the agency concerned cannot be deep-seated.

Red sunsets and afterglows are still observed, but the Krakatoa theory is becoming discredited. It has now come to light that similar phenomena were not uncommon in Australia before that great catastrophe.

Much definite information has been collected as to the rainfall in different parts of Australia. Only a fringe around the great continent—broad in some parts and narrow in others—has a sufficient rainfall to render agriculture successful. The arid centre has an average rainfall of from 5 to 10 inches per annum, and it is a matter of surprise that vast flocks of sheep can be maintained in such a region. Between these two districts runs a belt with from 15 to 20 inches of annual rainfall, the limit required for wheat-growing.

The first article printed is "On the Evidences of a Glacial Epoch in Victoria, during Post-Miocene Times," by G. S. Griffiths. The evidence, which he collects from purely geological, palæontological, and biological sources, appears *prima facie* conclusive.

Mr. James Stirling, F.L.S., of Omeo, continues his Phanerogamous Flora of the Mitta Mitta Source Basin.

Mr. W. W. Culcheth, C.E., discusses the formation of shingle on the East Coasts of New Zealand with reference to keeping open harbours and river-mouths.

Mr. P. H. Macgillivray, M.R.C.S., F.L.S., continues his researches on new or little-known Polyzoa, in two memoirs, and he also contributes a paper on the "Reproduction of the *Ornithorrhynchus*."

Mr. James Stirling, F.L.S., gives an elaborate account of the Meteorology of the Australian Alps.

The Ocean, a Treatise on Ocean-Currents and Tides and their Causes, demonstrating the System of the World. By WILLIAM LEIGHTON JORDAN, F.R.G.S. Second edition, abridged and revised. London: Longmans, Green, and Co.

THE fundamental idea of this work is to be found in the fifth chapter, where we have an investigation of *vis inertiæ*. As it is well known, Newton defined *vis inertiæ* as "an innate force of matter or power of resisting, by which every body, as much as in it lies, endeavours to persevere in its present state, whether it be of rest, or of moving uniformly forwards in a right line." (" Principia, Book I. Definition III.).

Our author does not accept Newton's definition. He argues "that any bodies have an innate tendency to move uniformly forward in a right line is mere assumption. . . . It is said that, in the simple case of a ball, thrown in the air and rolled on the ground, being set in motion, its *vis inertiæ* tends to keep it in motion until it is stopped by the resistance of the air or the friction of the gronnd against which it runs. This is an error. It is not the *vis inertiæ* of the ball which tends to keep it in motion. It is *vis inertiæ*, and *vis inertiæ* only, which stops and must in time stop the cause of that ball. *Vis inertiæ* resists the motion of the ball from first to last. . . . It thus appears that if, in any body whatever, there be not some motive force acting continuously to keep it in motion, its own inherent power of *vis inertiæ* must (even if no other cause arise) in the course of time bring it to rest.

The difference between Newton and Mr. Jordan is easily seen. According to the former, *vis inertiæ* causes matter to persist in its condition, whether of rest or of uniform rectilineal motion. According to Mr. Jordan, *vis inertiæ* causes matter not only to remain at rest, but if set in motion to tend to a return to rest.

Our author views the tides and the earth's rotation as the main causes of oceanic currents, and of the trade winds. Starting with the experimental fact that if a vessel containing water is set in motion the water tends to lag behind, he applies this principle to the hypothetical cases of a globe entirely covered by water, of an ocean surrounded by land, and to the case, as we actually find it, of an ocean whose movements are more or less intercepted by continents.

CORRESPONDENCE.

SIR LYON PLAYFAIR'S PRESIDENTIAL SPEECH.

In your article on Sir L. Playfair's Address (p. 611) you make what seems to me a serious omission. The speaker, in his recommendations concerning higher education, proposed that while colleges for the middle class should give a training pre-eminently scientific, those for the youth of the "upper ten thousand" should still, as now, be mainly classical and literary in their teachings. I submit that so long as such an arrangement prevails Science will never take the rank to which it is entitled. It will be contended that if Science is unfit for a prominent place in the education of the higher classes, it is of course something of a second-rate, shabby-genteel character, and in the schools intended for the middle classes it will be elbowed out as far as possible in favour of "gerund-grinding."

Adrian.

THE DIFFERENCE OF STATURE AND STRENGTH IN THE TWO SEXES.

A certain Dr. Bebel has been recently contending in a special work that "once upon a time" the average woman was equal in bulk and strength to the average man. Being, however, naturally dependent on their husbands during the seasons of gestation and lactation, they gradually decreased in bulk, and in power alike of mind and body became less able to provide for themselves, and were ultimately reduced to a state of "subjection," as it is called in the "gospel according to John Stuart Mill." This view seems to me utterly out of harmony with the teachings of organic Evolution. In all mammalian groups we find the males surpassing the females in size and weight, the distinction being very marked in the anthropoid apes. If, then, mankind were evolved out of any pre-existing mammalian form, there is a very strong probability, if not certainty, that from their earliest development men were superior to women in stature and strength.

Graduate.

NOTES.

"Time, space, substance, motion, shapes: these five embrace and include the whole of existence or being. They cannot be defined in terms of each other; time and space are not substantial entities. Time is simply time, and space is simply space. Time and space could never have begun to be, can never cease to be, but must just be always. Motion and shapes, though entirely dependent upon substance, are, nevertheless, not substance: light, heat, electricity, sound, &c., are actually not substance, but motion: stars, clouds, hills, stones, atoms, &c., are actually not substance, but shapes. Motion and shapes can begin to be, and can cease to be, therefore they constitute the creation. Motion is not force; force is that which produces motion; force is in substance; force is, in fact, substance. And it is actually inconceivable how aught else can produce motion except will; hence force must be called 'Will-force.' Substance, therefore, which is actually spirit, must have will-force, or it could not move itself into shapes. Those are the conclusions at which modern philosophic science is already arrived, and whoever has not heard them is not abreast of the age."

By the lamented death of Dr. W. B. Carpenter, F.R.S., the Royal Microscopical Society has lost one of its most valued Fellows: his work as a physiologist, and in connection with the University of London, has been already noticed in the various daily and other journals. His experience in the use of the microscope dates from a short time after the introduction of the achromatic instrument into this country; he is best known as an histologist by his researches on the Structure of the Shells of Mollusca, undertaken almost at the outset of his microscopical career, but considerably modified by his subsequent observations. The structure of Foraminifera was a subject he had made especially his own, and enabled him to pronounce a decided opinion as to the nature of a, at the time, much disputed fossil, *Eozoon Canadense*, specimens of which, prepared by himself, may be seen in the collection of the Royal Microscopical Society, and an inspection of which will do more to assist the micro-geologist than reading the whole series of controversial papers issued some years ago on the difficult subject of its real nature. He not merely examined the results of deep-sea dredgings, but accompanied more than one deep-sea expedition, and, although not one of the "Challenger" scientific voyagers, he did much towards working up that portion of the collection with which he was best acquainted. He was President of the Royal Microscopical Society in 1854 and 1855, and filled the chair of the younger society, "The Quekett Club," last year. Like all true men of science, he was always ready to communicate to others his vast store of knowledge; his kind assistance, so freely rendered, will be long remembered by those who enjoyed the privilege of meeting him.

During their financial year, ending Midsummer, 1885, the Council of the Royal College of Surgeons admit having paid upwards of £10,000 to examiners! Can we wonder that examinationism flourishes when it is so liberally endowed?

It appears that emissions of poisonous waters—possibly solutions of hydrogen sulphide—occur in the lagoons of atolls, destroying all fish, mollusca, and corals. Such an outbreak occurred at the Keeling Islands, in January, 1876, immediately after a cyclone of exceptional violence.

Of posthumous honours awarded to scientific men long after their death, the most striking instance is the erection of a monument to Archimedes, by the inhabitants of Syracuse.

According to M. Bonnal the temperature of an infant at the moment of birth is generally higher than that of the mother.

We regret to learn, from the "American Naturalist," that a party of English sportsmen wantonly killed from twenty to thirty of the bison-herd preserved in the Yellowstone National Park. A member of Congress has been fined for damaging the geyser-deposits.

At the Grenoble meeting of the French Association M. Mortillet read a paper in which he sought to prove that in the Tertiary epoch there existed an ancestral form of historic man, —an animal less intelligent than existing man, but more intelligent than the existing apes. He names this animal *Anthropithecus*.

Even Mexico feels the necessity of State aid to Science, and has established a *Comision Cientifica* for research into every department of human knowledge.

According to Lieut.-Col. Moody, 42 per cent of recruits applying for enlistment in the Army are rejected on the ground of bodily unfitness..

The Dufferin Terrace at Quebec is lighted electrically, the power being obtained from the Falls of Montmorency, at the distance of nearly 9 miles.

An epidemic among hares is raging in the central parts of France. The flesh of these animals, if eaten, occasions serious indisposition, though it presents no unusual appearance.

We regret to learn that the celebrated Godefroy Museum at Hamburg is in course of being broken up. A part of it has been purchased for the Museum of Leipzig.

The flowers of *Lantana camara*, of a deep golden yellow, change before fading to orange and scarlet; *L. nivea* opens white, and changes to blue; *L. mixta* also opens white, and changes through yellow and orange to red.

The predominance of the polar current during the year now drawing to a close has been exceptional, both in its dry and its rainy portions.

According to investigations made by the medical inspectors of the Local Government Board, schools, under the present system, rank among the chief agencies for spreading diphtheria.

The death of Dr. W. B. Carpenter deserves to be put on record. He was an opponent of Evolution and of Spiritualism, which he sought to account for by the grossly inadequate hypothesis of "dominant ideas."

According to the researches of Prof. O. Marsh, of Newhaven, brain-growth was an important element in the survival of animal species.

NOTICE.

With this number the "Journal of Science," at least under present auspices, will cease to appear. The Editor accordingly bids a kindly farewell to all his contributors, correspondents, and readers. He fully appreciates the sympathy and encouragement which he has received from thinkers of the most widely differing opinions. Most of all he is gratified by the abusive letters, chiefly anonymous, which have been addressed to him by Bestiarians. To have earned their vehement disapprobation is proof that his labours as "servus servorum Scientiæ" have not been in vain.

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